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ART. XXXIV.—*The Correlation of Physical, Chemical and Vital Force, and the Conservation of Force in Vital Phenomena;* by JOSEPH LECONTE, Professor of Geol. and Chem. in the South Carolina College, Columbia.

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MATTER constantly changes its *form*—but is itself indestructible except by the same power which called it into being. The same quantity of matter exists in the universe at all times. So also force changes its *form* constantly, but is itself indestructible, incapable of increase or diminution, and the same absolute amount of force exists in the universe at all times and forever. The mutual convertibility of the various forms of force is called "correlation of forces." The invariability of the absolute amount in the midst of constant change is called "conservation of force." This principle of correlation and conservation of force must be looked upon as one of the grandest generalizations in modern science, a principle startling at first, but when clearly understood and firmly grasped, almost axiomatic. It must be considered a necessary truth, and as such is a legitimate basis of deductive reasoning.

The correlation of *physical* forces is universally recognized as a principle in science, and not only so but has already been productive of many beautiful and useful *results;* but the correlation of physical and *vital* forces while generally recognized as a

probable fact has only been speculated on in a vague and as yet unfruitful manner. The science of life is scarcely yet ripe for the legitimate extension of this principle over its domain. The most elaborate attempt of this kind which I have seen, is contained in the very remarkable and suggestive paper of Dr. Carpenter entitled "mutual relation of physical and vital forces," and published in Phil. Trans. for the year 1850.

In the present paper I wish simply to present a few thoughts, which have originated in my own mind, in the course of reflection on this subject, in the hope that they may prove suggestive to others. They have at least the merit of being uninfluenced by the writings of others—and therefore perhaps of presenting the subject in a somewhat new light. I sincerely wish I could present the matter in a more definite form, but it is certain that where a subject is not perfectly understood, the attempt to give our ideas more definiteness also makes them more questionable. We are obliged to be content with a certain vagueness, in the hope that by the use of right methods a clearness will come after. We must gratefully accept the twilight in the hope that it marks the approach of the full light of day.

There are four planes of material existence which may be regarded as being raised one above the other. The *first* and lowest is the plane of elementary existence, the *second* the plane of chemical compounds, or mineral kingdom, *third*, the plane of vegetable existence and *fourth*, of animal existence. Now it is apparently impossible for any known force in nature to raise matter through all these grades at once. On the contrary there is a special force adapted for the elevation of matter from each plane to the plane above. It is the special function of chemical affinity to raise matter from plane No. 1 to No. 2. All the changes too which take place upon plane No. 2 by the mutual reactions of bodies situated on that plane, are under the guidance and control of this force. It is the special prerogative of the force of vegetation —of vegetable life, to lift matter from No. 2 to No. 3, i. e., from the condition of mineral matter to the higher condition of vegetable matter. All the changes which take place upon this plane, the laws of which constitute vegetable physiology, are under the guidance of this force. Finally, the force of animal life and that alone enjoys the privilege of lifting matter still higher into the 4th plane, i. e., the plane of animal existence. No force in nature can lift from No. 1 to No. 3, or from No. 2 to No. 4. Plants cannot feed entirely upon elementary matter, nor can animals feed upon mineral matter. The reason of this will be seen in the sequel. Thus it seems that after matter is raised from the elementary to the mineral condition, it requires an additional force of another and peculiar kind to raise it into the vegetable kingdom, and again another accession of force to raise it into the animal kingdom. These kingdoms are, there-

fore, truly represented as successive planes raised one above the other, thus:

No. 4, *Animal Kingdom.*
3, *Vegetable Kingdom.*
2, *Mineral Kingdom.*
1, *Elements.*

If then it be admitted that this is the relative position of these planes—that it requires a greater and greater expenditure of force to maintain matter upon each successive plane, then it follows *that any amount of matter returning to a lower plane by decomposition must set free or develop a force which may under favorable circumstances raise other matter from a lower to a higher condition.* Or to express it by a mechanical illustration, a given amount of matter falling from one plane to any plane below, develops a force sufficient to raise an equal quantity of matter an equal height. Thus *decomposition* must in every case *develop force*, which force may take the form of heat as in combustion, or electricity as in electrolysis, or may expend itself in forming chemical compounds or *even in organizing matter.*

Again, in the same manner as matter may be arranged in several distinct and graduated kingdoms, so it seems to me the forces of nature may also be properly divided into distinct groups arranged in a similar manner one above the other. These are the *physical*, the *chemical* and the *vital* forces. And as in the case of matter so also in the case of *force*, it is impossible to pass directly from the lowest to the highest group without passing through the intermediate group. The conversion of *physical* into *vital* force seems impossible without passing through the intermediate condition of *chemical force.*

These are the simple principles upon which are based all that follows—principles which may possibly seem fanciful to some unfamiliar with the principle of conservation of force, but the number of phenomena which they consistently explain will I hope entitle them to serious thought.

1st. It is well known that chemical elements, in what is called the "nascent condition" i. e., at the moment of liberation from previous combination, exhibit a peculiar energy of chemical affinity not exhibited under other circumstances. It seems to me that this is readily explicable on the principle of conservation of force. At the moment of decomposition the chemical affinity which bound the elements together and which was before satisfied, is suddenly left unsatisfied. There is an attraction *set free* which was before *disguised*—a force *liberated* which was before *latent.* If conditions favorable are present this force may preserve the form of chemical affinity, and expend itself in forming other chemical compounds; or even, as we shall see hereafter, in organizing matter. But if favorable conditions are not

present, then it may take some other form of force, e. g., heat or electricity, and *therefore no longer exist as chemical affinity.* The chemical affinity is said to be lost. To return to the mechanical illustration used above. Matter falling from plane No. 2 to plane No. 1 develops force sufficient to raise *other matter* from plane No. 1 to No. 2, but which in the absence of such matter may expend itself in heat or electricity or some other form of physical force.

2nd. It is a fact, now well established, that the *seed* in germination forms carbonic acid, and in doing so loses weight. That is, the organized matter of the seed is *partially decomposed*, a portion of its carbon uniting with the oxygen of the air to form carbonic acid. Now it is this *decomposition* which develops the force by which germination is effected. A portion of the organic matter of the seed is *decomposed.* This decomposition sets free a force which suffices to organize the rest. The force necessary and therefore the amount of decomposition necessary in this case is small because the work to be accomplished is simply the change from one form of organic matter to another, or rather from *organic* to *organized* matter—to recur again to the former illustration, merely shifting a certain quantity of matter from one place to another upon the plane No. 3. "But how," it may be asked, "is this decomposition brought about?" This seems to be effected by the heat and perhaps (according to Hunt) by the actinic rays of the sun.* Heat and actinic rays have been spoken of by many writers, e. g., by Carpenter and by Robert Hunt as the physical force which is changed into organizing force by means of the "substratum of an organized structure:" but the peculiarity of the view which I now present, is that this conversion does not take place *immediately*, but only *through the mediation of another force more nearly allied to the vital*, viz: *chemical force.* The food is laid up in the seed mostly in the form of starch. In the act of germination this starch is changed into sugar. Starch as is well known differs from sugar in two important respects, viz., it is *insoluble* and it is more *highly carbonized.*† Now according to the ordinary view, the only object of the partial decomposition is to change the food from an insoluble to a soluble form—and this can be done only by elimination of a portion of the carbon in the form of carbonic acid. According to the view which I now present, *the food is always laid up in a more highly carbonized condition than is wanted, in order that force may be set free by elimination of superfluous carbon.* According to the ordinary view, if an insoluble food could be found, capable of conversion into the soluble form, without loss of car-

* See Report by Robert Hunt on the growth of Plants, Rep. Brit. Assoc., 1846, p. 33, 1847, p. 30.

† Robert Hunt, Rep. Brit. Ass., 1847, p. 20–22. Carpenter, Comp. Phys., p. 288. Mülder, Chem. An. and Veg. Phys., pp. 208, 230.

bon; then germination of the seed might take place without loss of weight, by the direct conversion of heat into vital force. According to my view, *decomposition* and therefore *loss of weight, is absolutely necessary to develop the organizing force*, the loss of weight being in fact the exact measure of that force.

3rd. As soon as the plant develops *green leaves*, a complete change takes place in its mode of development. It no longer loses weight but increases in weight. It not only develops but *grows*. The reason of this is, that the organizing force is no longer developed by decomposition of food laid up within its own tissues, but by the decomposition of food taken *ab externo*. Sunlight is universally admitted to be the physical force concerned in this decomposition. Farther, it is generally supposed that there is a direct and immediate conversion of light into vital force in the green leaves of plants. But evidently this is impossible, since the *work done by the light is the separation of the two elements carbon and oxygen*. Light is therefore converted into *motion*. It is therefore the chemical affinity thus set free which is the force immediately converted into vital force. The food of plants consists of carbonic acid, water and ammonia (CO_2, HO and NH_3,) or in some cases according to M. Ville of CO_2, HO and N.* Sunlight acting through the medium of the green leaves of plants has the remarkable power of decomposing CO_2. The *force thus set free from a latent condition*, or the chemical affinity of *carbon in a nascent condition* is the force by means of which C, H, O and N are raised to the organic condition.† To return to my former illustration; matter (oxygen) falling from the second to the first plane develops force sufficient to raise other matter from the second to the third plane. Thus it is evidently *impossible on the principle of conservation of force that plants should feed entirely upon elementary matter;* whereas according to the ordinary view of the direct conversion of light into organizing force, there is no reason why plants should not feed entirely on elements, except that one of them, carbon, is insoluble.

4th. There are many other phenomena of vegetable life which receive a ready explanation on this theory. I have said that sunlight has the power of decomposing carbonic acid only in the *green* leaves of plants. *Pale plants*, such as the Fungi among cryptogams and the Monotropa among phænogams, have no power to decompose CO_2. These plants, therefore, cannot feed

* See review of the controversy between Boussingault and Ville on this subject, Bib. Univ. Arch. des Sci., vol. 30, p. 305. Also Phil. Mag., 4th ser., vol. 13, p. 497. Ann. des Sci., 4th series, vol. 2, p. 357. Am. Jour. Science, vol. 19, p. 409. Bib. Univ. Arch. des Sci., vol. 28, p. 335. Ann. des Sci., 4th series, vol. 7, p. 5.

† Ammonia is also probably decomposed in the tissues of the leaves of plants, (Carpenter, correlation of physical and vital forces, Phil Trans., 1850, p. 732. See also Morren, Bib. Univ. Arch. des Sci., new period, vol. 5, p. 84). This would of course produce additional organizing force.

upon chemical compounds—mineral matter. They *must feed upon organic matter*, which organic matter *in its partial decomposition furnishes the force necessary for organization.* If so, then this decomposition, as in the case of germination, must be attended with the elimination of CO_2. Both of these are known to be facts. Pale plants do feed upon organic matter and do evolve CO_2. The necessary connection of these facts with one another and with the principle of conservation of force, is now for the first time, as far as I know, brought out. The phenomena of nutrition in these plants is similar to that of seeds in germination, except that the latter contains the organic matter already laid up within its own tissues, while the former derives it from decaying vegetable or animal matter taken *ab externo* into its tissues. In this case too, as in germination, heat is apparently the physical force which effects the decomposition of the organic food, and which is therefore converted indirectly through chemical into vital force. Light is actually unfavorable to this process, for light tends to decompose, not to form CO_2. In both cases therefore the conditions favorable for nutrition are first, abundance of soluble organic matter, second, absence of light and presence of heat. This is then apparently the true reason why germinating plants and pale plants avoid the light. These plants grow by the *oxydation* of carbon and formation of CO_2. Light *decomposes* CO_2 and must therefore be antagonistic to its formation, and consequently to the growth of these plants Whether or not this property of light is entirely limited by the condition of its acting through an organic tissue, is a question yet undetermined. Heat we know is favorable to the oxydation of carbon (combustion, fermentation, putrefaction, &c.,) under all circumstances. Has light an opposite property also under all circumstances, or is this opposite property of light limited to the condition of its acting through the medium of an organism? I hope the experiments already commenced and still in progress, by my brother Prof. John LeConte, and published in the last proceedings and in the American Journal of Science and Arts, vol. 24, p. 317, will eventually furnish the means of solving this very important problem. I do not wish to anticipate the final results of these experiments, but it seems to me that the negative results thus far obtained, rather support the view that the action of light is not thus limited. In all experiments on this subject the light and heat of the sun have been combined. Now heat we know is favorable to combustion. The fact then that combined light and heat produced no effect, would seem to indicate that light counteracted the effect of the heat of the sun.

5th. *Etiolated plants*, or plants artificially blanched by exclusion of light, exhibit the same phenomena and for the same reason. These plants cannot receive their organizing force

through the decomposition of CO_2 by sunlight: therefore they are obliged to obtain it from decomposition of organic matter. Hence these plants require organic food, hence also they evolve CO_2 instead of oxygen. In this case also decomposition of organic matter, with a separation of a portion of the carbon in the form of CO_2, furnishes the organizing force. In the absence of any external organic matter in the form of humus or manure, etiolated plants like germinating seeds will feed for awhile upon organic matter previously accumulated in their tissues in the form of starch and actually *lose weight* of solid matter.*

6th. In a most interesting and suggestive article in the Bibliothèque Universelle (Archive des Sciences,†) on the subject of humus, M. Risler shows in the most conclusive manner that organic matter in a soluble condition (soluble humus) is taken up by *almost all plants*. This fact had been previously proved experimentally by Th. de Saussure, but having been denied by Liebig, it has been very generally neglected by vegetable physiologists. The doctrine of Liebig and of physiologists generally, is that, except in case of pale plants, organic matter is decomposed into CO_2, HO and NH_3, i. e., must fall into the mineral kingdom before it can be absorbed and assimilated by plants, and therefore that organic manures only supply the same substances, and in exactly the same form, which are already supplied, but in insufficient quantities, by the atmosphere. But M. Risler repeats with great care the experiments of de Saussure, and confirms the accuracy of his conclusions. Hyacinths and other bulbs were placed with their roots suspended in water colored with soluble extract of humus. When these plants were placed in the sun, the water became rapidly decolorized. Other roots such as carrots, also germinating grains of wheat, were observed to produce the same effects. An extract of humus was exposed at a somewhat elevated temperature to sunlight under a bell glass. Microscopic plants developed in great abundance. As long as these plants continued to develop the infusion was transparent and did not putrefy in the slightest degree: and yet there was a constant evolution of CO_2 as shown by analysis of the air in the bell-glass. "Now the cellules formed in the liquid contained carbon. This carbon did not come from the CO_2 of the air, for the liquid, far from *absorbing*, disengaged CO_2. Therefore the soluble humus must have furnished the carbon *directly* to the vegetable cells." It could not have furnished it *indirectly* in the form of CO_2 derived from decomposition of the organic matter, otherwise *oxygen* instead of CO_2 would have been eliminated. M. Risler thinks moreover that the *embryo* in germination takes up soluble organic matter in the form of humus in

* Carpenter, Comp. Phys., p. 285.

† Bib. Un. Arch. des Sci., new period, vol. 1, p. 305.

addition to the soluble organic matter contained within the cotyledons, and that the evolution of CO_2 by germinating seeds is due in part also to the oxydation of humus. Finally, according to the same author, the formation of roots in all plants, but particularly those containing much starch or sugar, is due to the direct absorption of humus, and not, as is generally supposed, by the fixation of carbon by means of light. "In order" says he "that CO_2 of the air should form these substances, it is necessary, in the beet and the potatoe, that there should be a descending sap, which there is not." Moreover if the carbon was taken from the soil in the form of CO_2 there should be elimination of oxygen instead of evolution of CO_2; but the converse is the fact as has been proved in the most indisputable manner by de Saussure and Boussingault.*

Mülder is equally explicit in affirming that plants absorb soluble organic matter which is converted in the roots, by elimination of a portion of the carbon, into starch and sugar.—Mülder, pp. 620, 664, 682. Thus according to these authors, *sap is actually elaborated by the roots* from organic manures.

Now according to the theory which I propose, *this change from humus into starch, sugar or cellulose, furnishes an additional life-force.* Humus is a more highly carbonized substance than either starch or cellulose. By the *partial decomposition of humus* in the tissues of the plant, with the elimination of a portion of its carbon (removed by oxydation) *a chemical force is set free which serves to assimilate the remainder.* Hence, this process of evolution of CO_2 as we have already said, is opposed by light but favored by darkness and heat. Light favors the formation of chlorophyll, of woody fibre, of essential oils, gums, &c.; darkness, heat and organic manures, favor the formation of sugar, starch, &c. Hence the explanation of the well known fact that by covering up the lower portions of potatoe plants by heaping earth around them, many buds which would otherwise form leafy *branches* develop into *tubers.* Hence also the explanation of the equally well known fact that the roots of plants seek and grow most rapidly in the direction of most abundant food. If the sap is elaborated entirely in the leaves, it is difficult to understand why the descending sap should flow in greater abundance in one direction than another. But if sap is elaborated in *the root itself* it is easy to see why growth is most rapid in the direction of most abundant manure. It is easy to see, too, why roots avoid the light; since light decomposes CO_2 and therefore must be unfavorable to the formation of this substance.

7th. It is a well known fact that the so-called *respiration of plants* consists of two distinct and apparently opposite processes, 1st, the absorption of CO_2 by the leaves and also in solution by

* Bib. Un. Arch. des Sciences, new series, vol. 1, p. 5.

the roots, the decomposition of this CO_2 by means of light with the fixation of the carbon and the elimination of the oxygen: 2nd, the recomposition and evolution of Co_2. The *decomposition* of CO_2 undoubtedly takes place in the leaves, but where the recomposition of CO_2 takes place is not so well ascertained. It is exhaled however, like the oxygen, from the leaves. The process of decomposition of CO_2 takes place only during the day as light is absolutely necessary for this process. The *recomposition* of CO_2 takes place night and day, although its exhalation according to some observers seems to be more abundant during the night. The process of decomposition of CO_2 is well understood—of that of recomposition our knowledge is very imperfect. M. Risler's explanation of this latter process seems most probable. Plants, we have seen, undoubtedly absorb soluble organic matter, i. e., humus. Humus we know is a more highly carbonized substance than cellulose or starch. This humus is therefore oxydized in the roots and interior of the trunk, away from light, by means of oxygen also absorbed by the roots and thus forms CO_2. This CO_2 then circulates in the sap to be exhaled by the leaves or perhaps to be again decomposed by sunlight in this organ. In the absence of light the whole is exhaled undecomposed. This readily accounts for the apparently greater exhalation of CO_2 during the night. A series of well conducted experiments would test the truth of this view. If it is true, there should be a relation between the richness of the soil in organic manures and the amount of CO_2 exhaled. For a given amount of growth, the amount of CO_2 exhaled is the measure of the amount of food taken up in the form of organic matter, and the amount of oxygen exhaled is the measure of the amount of food taken in the form of mineral matter. Or if the exhaled CO_2 is decomposed in the leaves during the day, then of course the difference between the amount exhaled during the night and day would enter as an element in the calculation. Also it would seem that those plants, especially, which frequent rich shady spots, should exhale proportionally more CO_2 and less oxygen, than those loving thin soils and sunny places.

In plants then, there are *two sources of organizing force*, the relative proportion of which varies infinitely, according to the amount of light, heat, color of the plant and richness of the soil in organic matters. The two sources are *immediately*, 1st, the decomposition of CO_2, 2nd, the decomposition of soluble highly carbonized organic matter: *remotely* the two sources are *light* and *heat*. In plants which first take possession of desert spots, bare rocks, &c., the *first* is the only source. In pale plants and fungi the *second* is the only source; but in most plants the two are combined in various proportions. The 1st must of course be considered the most fundamental and necessary, the 2nd being

evidently supplementary. The decomposition of CO_2 by sunlight may be considered as the original source of all vegetation, but in most of the higher orders of plants the process of nutrition is expedited by the reabsorption of organic matter before it again returns to the condition of CO_2, HO and NH_3.

8th. The *egg* during incubation, absorbs oxygen, evolves CO_2, and probably HO, and loses weight. As the result of this evolution of CO_2 we find the egg *develops*. What it *loses in weight* it *gains in organization*. Now what is the source of the organizing force? It evidently bears a direct relation to the loss of weight. Here also, then, we have *partial decomposition furnishing the necessary force*. A portion of the organic matter, falling from the organic to the mineral plane, sets free a force which raises the remaining portion into a slightly higher condition. Heat is evidently the physical force or agent which is transformed, not directly but *indirectly, through chemical affinity*, into vital force. In other words, heat is the agent which effects the necessary decomposition. The phenomena of development of the egg is, therefore, very similar to that of the seed.

9th. *After the hatching* of the egg, the animal no longer loses weight; because recomposition of food taken *ab externo* proceeds *pari passu* with decomposition. But in this case also *decomposition supplies the force by which recomposition is effected*, and growth and development carried on. As this is an important point I will attempt to explain it more fully.

It is well known that in the animal body there are, going on constantly, two distinct and apparently opposite processes, viz., decomposition and recomposition of the tissues; and that the energy of the life is exactly in proportion to the rapidity of these processes. Now according to the ordinary view, the animal body must be looked upon as the scene of continual strife between antagonistic forces chemical and vital; the former constantly tearing down and destroying, the latter as constantly building up and repairing the breach. In this unnatural warfare the chemical forces are constantly victorious, so that the vital forces are driven to the necessity of contenting themselves with the simple work of reparation. As cell after cell is destroyed by chemical forces, others are put in their place by vital forces, until finally the vital forces give up the unequal contest and death is the result. I do not know if this view is held by the best scientific minds at the present day, as a fact, but it certainly is generally regarded as the most convenient method of representing all the phenomena of animal life, and as such has passed into the best literature of the age. Certain it is however that the usual belief, even among the best physiologists, is that the animal tissue is in a state of unstable equilibrium; that constant decomposition is the result of this instability, and that this *decomposition and*

this alone, creates the necessity of recomposition—in other words creates the necessity of food. But according to the view which I now propose, decomposition is *necessary to develop the force* by which organization of food or nutrition is effected, and by which the various purely animal functions of the body are carried on—that decomposition not only creates the *necessity* but at the same time furnishes the *force* of recomposition.

But it will no doubt be objected that according to the principle of conservation of force, decomposition of a given amount of matter can only effect the recomposition of an equal amount—that a given quantity of matter falling a given height, can only raise an equal quantity an equal height: the whole force developed by decomposition seems to be expended in maintaining the body at a given position. How then can *growth* and *animal activity* go on? The answer to this question is obvious enough when we recollect the nature of the food of animals. Animals it is well known cannot feed upon mineral matter but only on food already organized, at least up to the vegetable condition. But when decomposition takes place, the animal matter returns no longer to the vegetable condition from which it was immediately raised, but to the mineral condition. It is decomposed into CO_2 HO and *urea*. This last substance though not strictly a mineral substance is far below the condition of vegetable matter. Thus it is evident that *a given quantity of matter falling down from the condition of animal to that of mineral matter*, i. e., from the 4th to the 2nd plane, *would develop force sufficient to lift a larger quantity of matter from the vegetable to the animal condition*, i. e., from the 3rd to the 4th plane, and yet perhaps leave much residual force unexpended. Thus it is possible, and not only possible but certain, on the principle of conservation of force that decomposition of animal tissues should set free, a force, a part of which is consumed in the recomposition of a *larger* amount of new matter and thus maintaining growth; a part in animal heat and a part in animal activity of all sorts. In this view of the case we see at once the absolute necessity that the food of animals should be organized. Upon the principle of conservation of force, growth and animal activity, in a word, animal life, would otherwise be impossible.

It follows also from the above, that the higher the organization of the food the smaller the amount of force necessary to effect assimilation, and therefore the larger the amount of residual force to be expended in animal heat and animal activity. In this we find a ready explanation of the superior activity of *carnivorous* animals, and the loss of animal activity which results in a state of domestication from the use of vegetable diet; also of the supposed superior activity of men fed upon meat diet.

10th. I have spoken thus far of only one source of vital force in animals, viz., the *decomposition of the tissues.* I have attempted to show how, upon the principle of conservation of force, this is sufficient to carry on the growth and the activity of the animal organism. But decomposition of the tissues, though the fundamental source—the source characteristic of and peculiar to animals—of immediate and universal necessity in this kingdom, and in many cases sufficient of itself, is not the only source. There is also in animals as in plants a supplemental source, viz., *the decomposition of food.*

It is well known that the food of animals consists of two kinds, the nitrogenous, such as albumen, fibrin, casein, &c., and the non-nitrogenous, such as fat, starch, sugar, gum, &c. According to all physiologists since Liebig, the nitrogenous alone are used in the repair and growth of the tissues. The non-nitrogenous are either quickly consumed in respiration, or else are laid up in the form of fat for future consumption in the same way. Now there can be no doubt that animals may live entirely on nitrogenous food; in which case the whole vital force, whether for assimilation of food or for animal heat and animal activity, is derived from the decomposition of the tissues. This is the case also, apparently, in the starving animal, particularly if lean. But in almost all cases much food in the form of fat, starch, sugar, &c. (non-nitrogenous), is never transformed at all into tissues, but is taken into the blood, gradually decomposed, oxydized in the course of the circulation, changed into CO_2 and HO, and finally removed by exhalation from the lungs. Now what is the object of the non-nitrogenous food, since these do not form any part of the tissues but are again decomposed and thrown out of the system? The answer usually given is that such food is used in the animal economy solely as fuel to keep up the animal heat. On this view it is difficult to see why this class of food should be used at all, especially in warm climates. But according to the view which I propose we have here an *additional source of vital force.* The decomposition of these ternary compounds sets free a force which is used in organizing and assimilating other matter (nitrogenous) and in producing animal activity and animal heat. As in plants, although the decomposition of CO_2 by sunlight is all that is absolutely necessary for growth and development, yet the decomposition of organic food supplies an additional force which greatly increases the vigor and rapidity of vegetation; so in animals, although *decomposition of the tissues* is all that is absolutely necessary to furnish the force of growth and the phenomena of animal life generally, yet the decomposition of non-nitrogenous organic *food* furnishes additional force by which growth and animal activity may be maintained without too great expenditure of the tissues.

11th. In what then consists the essential difference between animals and plants? There can be no doubt that it consists, generally, in their relations to one another and to the mineral kingdom. Plants occupy a middle ground between the mineral and animal kingdom—a necessary halting place for matter in its upward struggles. But when we attempt to define this relation more accurately, the problem becomes much more difficult. It is indeed probable that no single distinction will be found free from objection. The commonly received and, to a certain extent, very correct idea is, that the essential distinction consists in their relation to CO_2. Plants *de*compose and animals *re*compose CO_2. The beautiful manner in which the two kingdoms stand related to each other through these converse processes, is familiar to all. But it is well known that most plants carry on both of these processes at the same time, while some, as fungi, pale plants, &c., only recompose CO_2 like animals. It seems to me that at least an equally good fundamental distinction may be found in this, that in plants the fundamental and necessary source of vital force is the decomposition of its *mineral food;* while in animals the fundamental source of vital force is the decomposition of its *tissues.* It is true that in what I have called the supplementary source of vital force they seem to meet on common ground, viz., the decomposition of *organic food;* but even here there is this essential difference, that in plants this decomposition of organic food is only partial, and therefore furnishes not only *force* but *material* for organization; while in animals the decomposition is complete and therefore furnishes only *force.*

As a necessary result of the above, it would seem that the "*vortex*" of Cuvier is characteristic of animals. There seems no reason to believe that a tissue once formed in plants is ever decomposed and regenerated, as is the case in animals. When plant-cells decompose, the tissue dies. Hence the absolute necessity of *continuous growth* in plants. In this kingdom *life* is synonymous with growth. There is no possibility of life without growth. There is no such thing as determinate size, shape, or duration. There is no such thing as maturity, or if so, death takes place at the same instant. As cell life is necessarily of short duration, and as there is no regeneration of tissues in plants, it is evident that the life of the tissues must be equally short. Thus plant life can only be maintained by the continual formation of *new tissue* and a constant travelling of the vital force from the old to the new. In exogenous plants the direction of travel is from the interior to the exterior; in endogens from exterior to interior, and still more from below upwards by the continual addition of new matter at the apex. In fungi where there is no such superposition of new tissue upon the old, where

growth takes place by multiplication of cells throughout the whole plant—in other words, a true interstitial growth as in animals—since there is no regeneration of tissues, the duration of the life of the plant is limited by the duration of cell-life.

The *respiration* of animals, also, differs essentially from that of plants. At one time the absorption of CO_2 and exhalation of O was called the respiration of plants. It is universally admitted now, however, that this is rather a process of assimilation than of respiration. The recomposition and exhalation of CO_2, as soon as discovered, was very naturally likened to animal respiration, and is in fact looked upon by many, as for example the physiologist Carpenter, as a true respiration. But there is an essential difference between this and animal respiration, which I have already pointed out. Its very significance is radically different. The essential object of animal respiration is the removal of poisonous decomposed matters from the organism. The so-called respiration of plants, on the contrary, is rather a process of assimilation, since by it the too highly carbonized organic food, by the elimination of a portion of its carbon, is brought into a proper condition for organization. A true respiration is necessarily connected with a change of the matter of the tissues—with the vortex of Cuvier—which has never been shown to exist in plants. It is true the exhalation of CO_2 has been looked upon by some physiologists as indicative of a regeneration of tissues, but I have already shown that this is probably not the case, but on the contrary that the CO_2 is formed by the partial decomposition of highly carbonized organic *food*.

12th. The most natural condition of matter is evidently that of chemical compounds, i. e., the mineral kingdom. Matter separated from *force* would exist, of course, only as elementary matter or on the *first plane;* but united with force, it is thereby raised into the *second plane* and continues to exist most naturally there. The *third plane* is supplied from the second, and the fourth from the third. Thus it is evident that the quantity of matter is greatest on the second and least on the fourth plane. Thus nature may be likened to a pyramid, of which the mineral kingdom forms the base and the animal kingdom the apex. The absolute necessity of this arrangement on the principle of the conservation of force may be thus expressed. *Matter*, *force* and *energy* are related to one another in physical and organic science somewhat in the same manner as *matter*, *velocity* and *momentum* in mechanics. The whole *energy* remaining constant, the greater the *intensity* of the force (the elevation in the scale of existence) the less the quantity of matter. Thus necessarily results what I have called the pyramid of nature, upon which organic forces work *upwards* and physical and chemical forces *downwards*.

13th. As the matter of organisms is not created by them, but is only so much matter withdrawn, borrowed as it were, from the common fund of matter, to be restored at death; so also organic forces cannot be *created* by organisms, but must be regarded as so much force abstracted from the common fund of *force*, to be again restored, the whole of it, at death.* If then vital force is only transformed physical force, is it not possible, it will be asked, that physical forces may generate organisms *de novo?* Do not the views presented above support the doctrines of "equivocal generation" and of the original creation of species by physical forces? I answer that the question of the origination of species is left exactly where it was found and where it must always remain, viz., utterly beyond the limits of human science. But although we can never hope by the light of science to know *how* organisms originated, still all that we do know of the laws of the organic and inorganic world seem to negative the idea that physical or chemical forces acting upon inorganic matter can produce them. Vital force is transformed physical force, true, but the necessary *medium* of this transformation is an organized fabric; the necessary condition of the existence of vital force is therefore the previous existence of an organism. As the existence of physical forces cannot even be conceived without the previous existence of matter as its necessary *substratum*, so the existence of vital force is inconceivable without the previous existence of an organized structure as its necessary substratum. In the words of Dr. Carpenter, "It is the speciality of the material substratum thus furnishing the medium or instrument of the metamorphosis which establishes and must ever maintain a well marked boundary line between physical and vital forces. Starting with the abstract notion of force as emanating at once from the Divine will; we might say that this force operating through inorganic matter, manifests itself as electricity, magnetism, light, heat, chemical affinity and mechanical motion; but that when directed through organized structures, it effects the operations of growth, development and chemico-vital transformations."

* Carpenter, Phil. Trans., 1850, p. 755.

ART. XXXV.—*Report on the Exploration of two Passes, (the Kootanie and Boundary Passes) of the Rocky Mountains in* 1858; by Captain BLAKISTON, Royal Artillery. (With a map.)*

[WE have been favored by General Sabine through Dr. A. D. Bache with an early copy of Captain Blakiston's Report, which with its accompanying map we take pleasure in bringing before our readers. Capt. B. was detached from his position as Magnetician to the expedition of Capt. J. Palliser for exploring British N. America, for the purpose of taking command of the party whose adventures and discoveries he records. The Victoria Gold Medal of the Royal Geographical Society has just been awarded to Captain Palliser for the successful results of his exploration of large tracts in British North America, and more particularly for the determination of the existence of these practical passes across the Rocky Mountains within the British Territories.

The interest of Capt. Blakiston's Report will not be diminished by the appendix we add to it from Sir R. I. Murchison's anniversary address, detailing some of the results of the Palliser Expedition.—EDS.]

On the 12th of August, 1858, I left the camp of the main body of the Exploring Expedition at the site of Bow Fort, base of the Rocky Mountains, lat. 51° 9′ N., long. 115° 20′ W., and after crossing the Bow River by a ford about four miles above that point, I gained ground to the eastward, so as to get clear of the broken and wooded country on the edge of the mountains.

My party consisted of three Red River half-breed voyageurs, Thomas Sinclair, Amable Hogg, and Charles Racette, besides a

* To H. MERIVALE, Esq., *Under Secretary of State for the Colonies.*

13, Ashley Place, April 18, 1859.

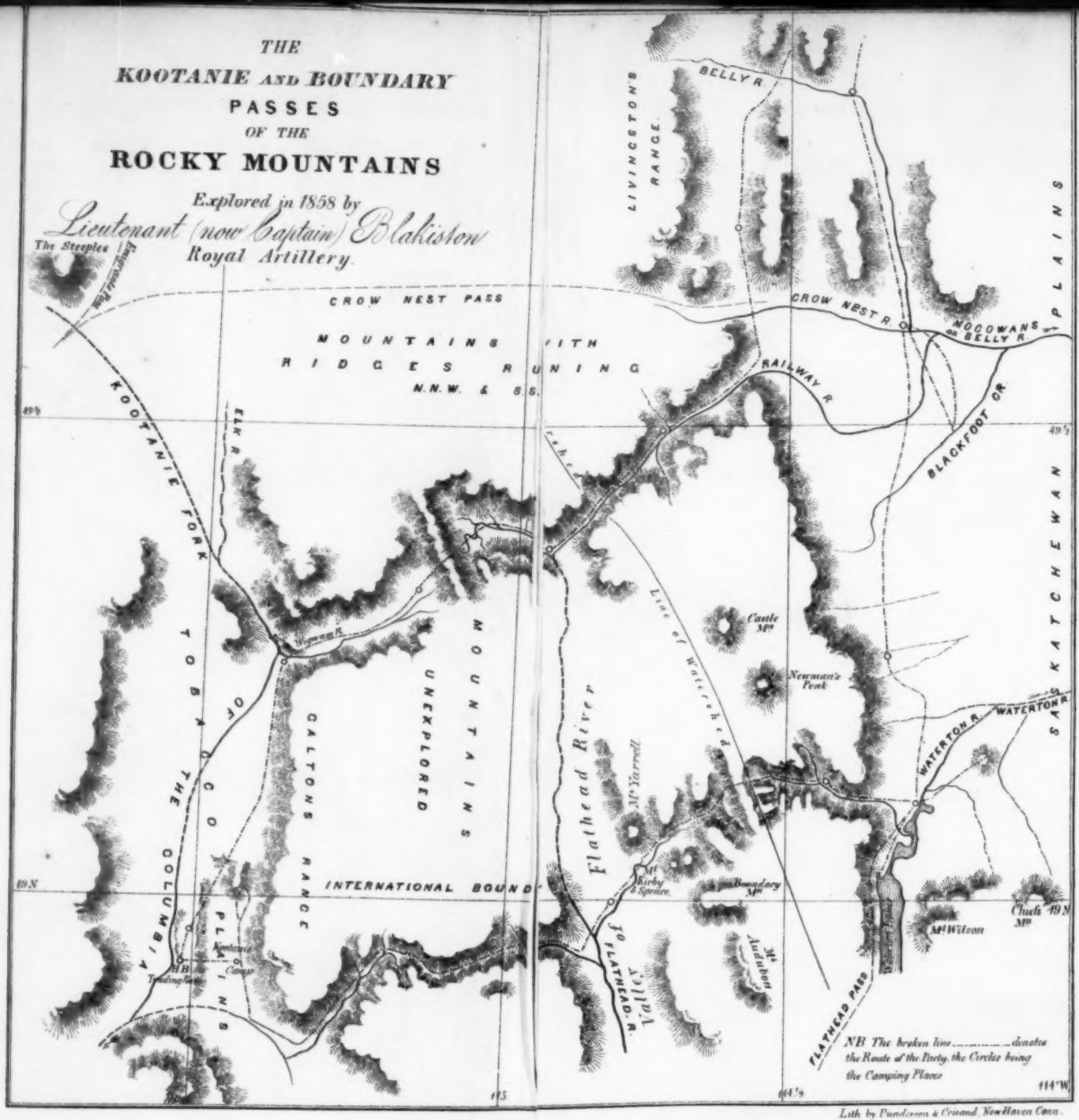
SIR,—I have the honor to enclose a Report which I have received by post from Captain Blakiston of the Royal Artillery, with a request that it should be transmitted for the information of H. M. Government.

The Report, with Map and Sections, states the particulars of Captain Blakiston's Explorations of the Kootanie and Boundary Passes of the Rocky Mountains; the first known only by name, and the second unknown, except to the native Indians; the Kootanie Pass proving to be the most southern, and by far the shortest yet known in the British territory.

I have at the same time received from Captain Blakiston a continuation of the magnetic observations which constituted his special duty, up to the date of the transmission of his letter. These evince the same care and skill which have characterized his former observations. The results will be laid before the Royal Society, as those of his earlier observations have been.

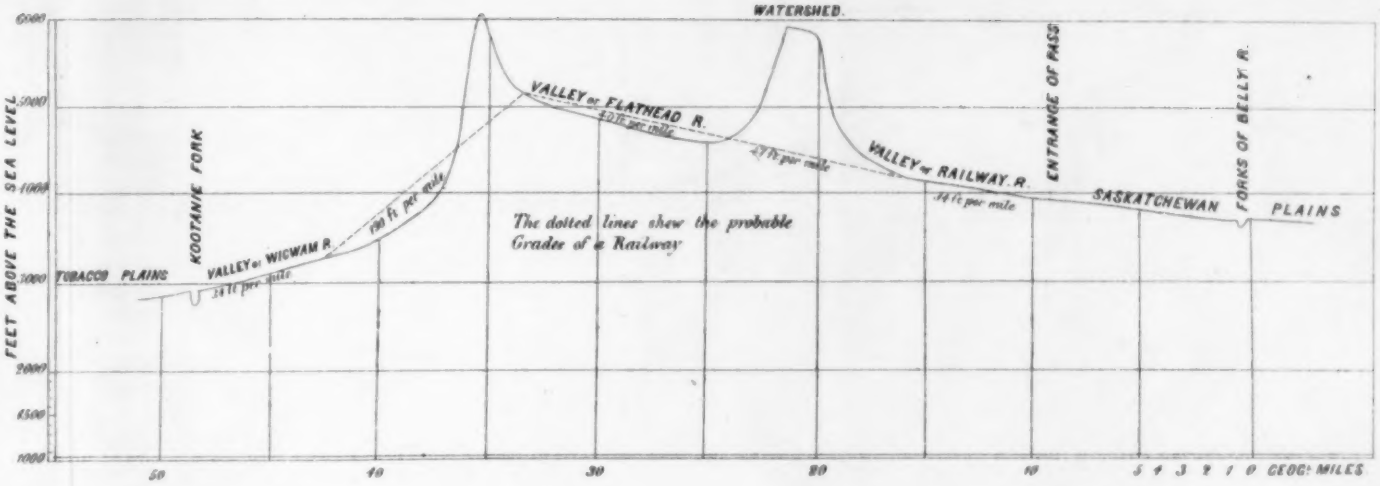
In the successful conduct of the exploration confided to him by Mr. Palliser, Captain Blakiston has had an opportunity of manifesting his desire and capability of contributing towards the accomplishment of the Geographical objects of the expedition, which will, I trust, obtain for him the approval of H. M. Government.

(Signed) EDWARD SABINE, Major-General, R. A.


THE
KOOTANIE AND BOUNDARY
PASSES
OF THE
ROCKY MOUNTAINS
Explored in 1858 by
Lieutenant (now Captain) Blakiston
Royal Artillery.
The Steeples
CROW NEST PASS
MOUNTAINS WITH RIDGES RUNING N.N.W. & S.S.
KOOTANIE FORK OF THE COLUMBIA
ELK R
Wigwam R.
CALTONS RANGE
UNEXPLORED MOUNTAINS
INTERNATIONAL BOUNDARY
Flathead River
Line of Watershed
Mt Kirby & Spence
Mt Farrell
Boundary Mp
Mt Audubon
Jo FLATHEAD R.
Valley
FLATHEAD PASS
Castle Mp
Newman's Peak
LIVINGSTONS RANGE
BELLY R
CROW NEST R
NOCOWANS or BELLY R
RAILWAY R
BLACKFOOT CR
SASKATCHEWAN PLAINS
WATERTON R
WATERTON R
Chuck Mp
Mt Wilson
NB The broken line ..... denotes the Route of the Party, the Circles being the Camping Places
49½
49 N
115
114½
114°W
Lith by Punderson & Crisand, New Haven Conn.
Scale of Geogl Miles to an Inch
70 60 50 0

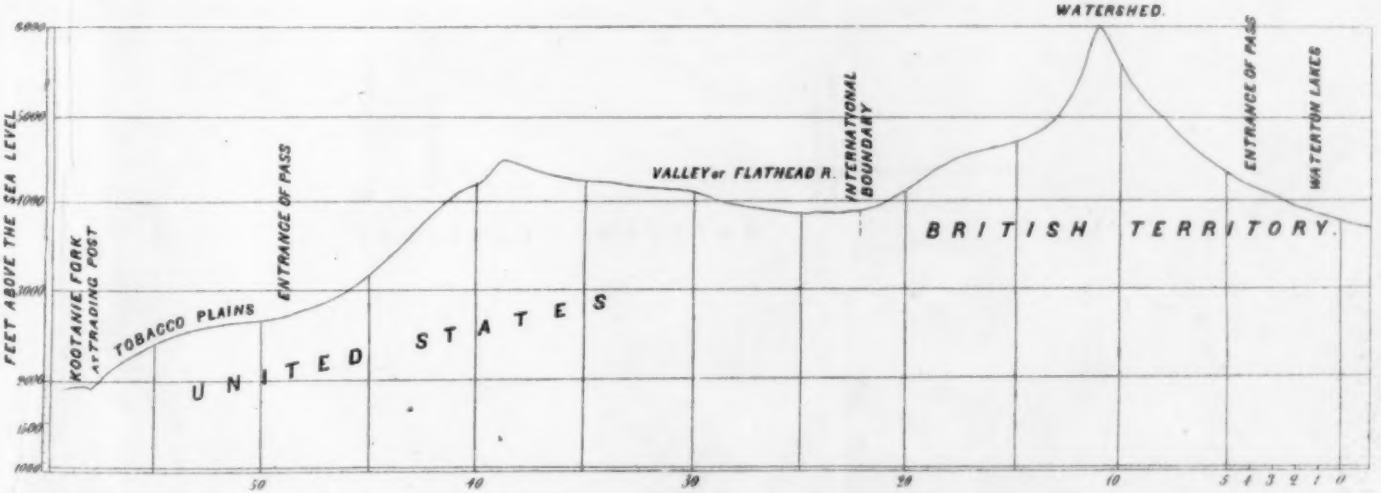
SECTIONS.

N°1 THE KOOTANIE PASS.


WATERSHED.
VALLEY or FLATHEAD R.
VALLEY or RAILWAY. R.
ENTRANCE OF PASS
FORKS OF BELLY R.
KOOTANIE FORK
VALLEY or WIGWAM R.
TOBACCO PLAINS
SASKATCHEWAN
PLAINS
The dotted lines shew the probable Grades of a Railway
FEET ABOVE THE SEA LEVEL
50 40 30 20 10 5 4 3 2 1 0 GEOG: MILES

Horizontal Scale 8 Geog! Miles to an inch. *Vertical Scale 2000 feet to an inch.*

N°2 BOUNDARY PASS.



Thickwood Cree Indian "James," whom I had engaged as hunter to the party. I had ten horses, five of which were used for riding, and the rest carried the packs, containing a quantity of ball and powder, tobacco, a few knives, and other articles of small value for Indian trade; also some dried meat and pemmican, with tea, sugar and salt, as well as two boxes containing my instruments, books, &c.

Soon after leaving Bow River, we crossed one of its tributaries, the Kananaskasis or Lake River, a rapid stream coming out of the mountains from the southwest; here we saw the remains of many wooden carts, which had been abandoned by a party of emigrants from Red River Settlement, under the late Mr. James Sinclair, on their way to the Columbia, in 1854, who had found it impossible to drag them further into the mountains. This pass, I believe, follows the course of the river to its source, and is the one by which Sir George Simpson governor of the territories of the Hudson's Bay Company, as well as another party of emigrants crossed the Rocky Mountains in 1841. In the past season it was travelled by Capt. Palliser.

The forest consists of spruce (*Abies alba*), a small pine (*P. Banksiana*), and another rough-looking *Abies* which grows to a large size, also a few balsam poplar, and aspen. In travelling through these mountain forests, the greatest obstruction is the fallen timber, which lying about in all directions, causes much exertion to the horses, and confines them to a slow pace. During this first day's travel I noticed the devastating effects of a tempest; numbers of trees had been blown down, and many broken short off. The work of destruction had evidently been of this year, but there were also signs of former work of the same character.

The following day, our course still tending a good deal to the eastward, carried us farther and farther from the mountains, but we passed within twelve miles of a marked outlier, which from its peculiar form, I called "The Family." After this as we travelled along through a partially wooded country, and receding from the near hills which obstructed the view, a sharp peak entirely covered with snow, opened to us at about forty miles distance. The wind was from the westward, and to the east of the summit of the peak rested a mass of white cloud, which was very marked, for there were no other clouds to be seen, with the exception of a few light cirri over head. This attending cloud gave the mountain the appearance of an active volcano, and the effect against the clear sky was extremely beautiful. The phenomenon was caused by the aqueous vapor of the warm Pacific breeze, being condensed by the coldness of the snow, and appearing as a cloud to the leeward of the peak. I took careful

bearings of this mountain, to which I gave the name of "The Pyramid."

We camped at the forks of a creek, called by our hunter the "Strong Current." Here he was successful enough to procnre a few fine mountain trout, which proved a very agreeable change to our ordinary fare, which consisted of dried buffalo meat, containing by no means too large a proportion of fat, washed down by tea. Bread was not in our bill of fare, and I may here state, that during the whole summer while travelling, with the exception of two Sundays, I never tasted a morsel of farinaceous food. This may appear astonishing, but when continually travelling, with the appetite sharpened by a ride over the prairie in the cool breeze of the mountains, one becomes acccustomed to do without flour, salt, sugar, &c., which under other circumstances would be considered indispensable.

The next day was Saturday; we rose early, packed the horses, and made a start as usual about sunrise, and travelled on through much the same sort of country, the up-lands being generally wooded, while the bottoms were partially covered by scrub-willow and other bushes. We halted between 8 and 9 A. M. for breakfast, giving the horses a "spell" of a couple of hours or so; then started again, and gained a somewhat elevated position, from which we had an extensive view of a fine valley, watered by two clear mountain streams, which as they neared the edge of the great plains, stretching probably without break for 700 miles eastward, united, and with mingled waters, pursued their course towards Bow River, ultimately to pour themselves into the icy basin of Hudson's Bay. We continued on until we reached the southernmost of the two creeks, within ten yards of which, under the shade of some fine poplars, I pitched my small patrol tent. The valley bottom was a fine piece of prairie pasture for the horses, and presented a most suitable resting-place for a Sunday camp. I had (for it was only two o'clock), halted in sufficient time to allow me to obtain an observation of the sun during the afternoon for comparison with one I hoped to obtain on the morrow, and so rate my chronometer. This important instrument was carried each day, turn about, by one of the men, who for that day did nothing else but carry it as carefully as possible. I would recommend this plan to future explorers. In a large party, a few of the steadier hands should be selected for this service; but the same man should never be obliged to carry the instrument every day, lest he become careless.

My ordinary mode of travelling, gave the horses six to seven hours' work per day, with the exception of Sundays. Frequently I halted from breakfast till noon, in order to obtain an observation for latitude, in which case I camped later. I never, however, gave up the plan which I adopted from the first, of making

an early start, and getting the best part of the day's work over before noon. There are many reasons in favor of it. The horses were mostly Indian ponies, which are hardy and work well on grass. They grow somewhat lean while living out during the severe winter weather, but fatten rapidly with the appearance of the new grass in the spring. They are not accustomed to shoes, but I had some on three of them, whose feet I considered too much worn down for the rocky ground of the mountains. On camping, the horses after being watered, are left to themselves for the night, the fore legs of those likely to wander being hobbled with a piece of soft leather. They are very sagacious in following a trail. The 15th of August was a Sunday. While continually travelling, it will be found that rest one day in seven is required by man and horse, the former taking advantage of it to wash and mend clothes.

The weather continued fine, and this day the thermometer rose to 85° in the shade, with a clear sky, and fresh breeze off the mountains in the afternoon, the day closing with a calm evening. This mountain breeze appears to be a regular occurrence during the fine summer weather of this season. On each of three successive days of fine weather which we enjoyed at the site of Bow Fort, the morning was calm, at about 7½ A. M., the wind commenced lightly from about W.S.W. off the mountains, and gradually increasing in the middle of the day and afternoon it blew a fresh breeze from the same point, with usually some *cumuli* over the mountains, which disappeared before reaching the plains; in the evening the wind fell, and the night was calm. The explanation of this phenomenon is the same as that of the sea breeze so unvarying in tropical islands, namely, that as the sun gains altitude, the great plains which are entirely prairie become heated, and consequently, the air in contact with them ascends and is replaced by the cooler air from the mountains.

Our general course for the next three days was a point east of south, for we were now as far out from the mountains as our Indian thought requisite. We were, however, within the outlying ridges, which are numerous, and all run parallel to the larger ranges of the great chain, namely, S.S.E. Thus travelling the course we were on, we had very seldom to surmount any high land, but passed along the valleys between these ridges.

The country was less wooded than that previously passed, being for a considerable part, fine prairie slopes. The main range or watershed, as I supposed it to be, was occasionally visible, through gaps in the nearer mountains, at a distance of about thirty miles.

On the 16th our hunter was lucky enough to procure us some fresh meat in the shape of a wupite or wa-waskasew (red deer)

of the Crees. In order to lighten the burthen of the horses and preserve the meat, the bones were taken out, and it was cut into thin flakes and half-dried over the night camp fire.

The same afternoon, as we arrived at Trap Creek, just above its junction with High Woods River, we found six tents of Thickwood Stone Indians who were just preparing their encampment. We camped along with them, and as usual, when with or near any Indians, my flag, a St. George's Jack, was hoisted on a pole in front of the tent. I gave them a present of some tobacco and fresh meat. These Stone Indians, with whom are associated also a few Crees, and whose hunting ground is the wooded and semi-wooded country along the base of the mountains, like the head-natives of the Saskatchawan, are a harmless and well disposed people towards the whites. Education has, thanks to the former Wesleyan missionary, the Rev. Mr. Rendall, and his successor the Rev. Thomas Wolsey, made some little progress amongst them; a few being able to read and write the Cree syllabic characters, now in general use among the missions of the northwest.

During the afternoon I held a talk with these Indians. I told them plainly for what reason we had been sent to the country; that Her Majesty was always glad to hear of their welfare, and that any message which they might have for her, I would take down in writing.

"We are glad," said an old man, "that the great woman chief of the whites takes compassion upon us, we think she is ignorant of the way in which the traders treat us; they give us very little goods and ammunition for our furs and skins, and if this continues our children cannot live. We are poor, but we work well for the whites. The Indians of the plains treat us badly and steal our horses, but we do nothing to them, for the minister tells us so." In answer to questions from myself, they said that they would wish white people to come and live among them, and teach them to farm, make clothes, &c., so that "their children might live," for the animals are getting every year more scarce. I may here state, that I have been fortunate enough this year to fall in with many camps of the different tribes of Indians inhabiting this country, from whom I always obtained as much information as possible on their present state, and their wishes as to the future; and I hope to draw up a report on the same for the information of H. M. Government; for without doubt, when deciding on the future of this country, some provision should be made for the poor uncivilized beings, to whom by right the soil belongs.

From these Indians I obtained a pair of saddle-bags of which I was in want, and by giving in barter a little ammunition and obacco, I changed a lame horse which I had brought with me or that purpose, for a good strong Indian pony.

Crossing Spetchee or High-woods River on leaving the Indians in the morning, we travelled over undulating prairie all the forenoon, crossing another tributary of this river. During the latter part of the day, we passed through a narrow wooded ravine between rugged hills, covered with burned forest, and camped on a small creek. Here I determined to make a cache. Therefore selecting a good thick spruce tree, we enclosed in a box some ammunition, tobacco, and a few other things, which with half the bag of pemmican still remaining intact, rolled up in a piece of buffalo robe, we suspended from a branch about fifteen feet from the ground.

We were delayed some time next morning by some of the horses having strayed a distance into the woods during the night; however, when found they were quickly unhobbled, saddled, and packed, and we started not very long after our usual hour. The Indian trail led between numerous wooded ridges, but the greater part of the wood was burned. The soil of the valleys was usually a deep dark mould, supporting a luxuriant vegetation of the smaller plants. This is the nature of most of these mountain valleys. Where the strata are upheaved to the surface, the ground is of course rocky; such is, however, not often the case in the valleys, but the lines of strata running along the ridges are distinctly visible even when the grass is growing, owing to the difference of color of the grass on the almost bare rock. The strata run in the direction of the ridges, namely, a little east of south, and usually dip from, but in some few cases towards, the mountains, and at a considerable vertical angle.

In the afternoon we passed close on the left hand a very remarkable feature; it was a mass of rock projecting upwards from the top of a hill, and visible at a considerable distance; from its peculiar form I called it the "Chopping Block." Soon after, we gained the height of land between the waters of the Spetchee and Mocowans, or Belly River, and the wide prairie valley of the latter broke upon our view. We descended a short distance and camped at the first wood and water.

Before gaining Belly River in the morning, the quick and practised eye of the Indian caught sight of a herd of Buffalo in the valley, he therefore went ahead, and by the time we had halted on the river, and I had obtained an observation, he had killed one animal. I remained here until noon, in order to obtain a meridian altitude, and so complete my observation for latitude and longitude, occupying a portion of the time in measuring the heights of the successive river levels with the aneroid barometer.

These "river levels" are a very general feature in this portion of the Western Continent; I have observed them on all parts of

the Saskatchawan above the forks, and its tributaries issuing from the Rocky Mountains, as well as on the Kootanie fork of the Columbia on the west side, and the Flathead River in the mountains, from an altitude of 1000 to upwards of 4200 feet above the sea. They are in some places very marked, and appear as a succession of steps from the bed of the river to the level of the plain above, often in sight for miles, and running horizontally along either side. The tread of the step is of greater or lesser width, the rise nearly always abrupt and well marked. They were very decided in the valley of Bow River at the base of the mountains, where they appeared cut with mathematical accuracy.

The levels measured at Belly River were:—

	Above the sea.
Present bed of the river, - - - - -	4024
1st, river level, - - - - - - -	4085
2nd, " - - - - - - -	4176
3rd, the level of the valley, - - -	4226

These river levels are for the most part, on the lower portions of the branches of the Saskatchawan, on a somewhat larger scale in vertical height, than near the sources.

I was now on Belly River at about the same altitude as on Bow River at the site of Bow Fort, namely, 4000 feet above the sea, although eighty-seven miles (geographical) in a direct line S.S.E. from it. From this point the route of the party may be traced on the plan attached to this report. The plan does not include the country to the northward, which has no connection with the passes reported upon. I have, however, the whole country mapped on a smaller scale.

The bed and sides of this river are rocky, the strata of hard gray sandstone, much inclined, and the current obstructed in places by immense granite boulders. We found no difficulty in crossing, the water though running swiftly, being not deeper than three feet, and about twenty-five yards across.

Looking through the gap in the near range through which the river issues, I saw a conspicuously dome-shaped mountain. It afterwards proved to be when seen from the plains, and also from the top of a mountain in the Kootanie pass, the highest and almost only peak rising above the others in this part of the mountains. After the distinguished British naturalist, I named it "Gould's Dome." The gap through which I had seen this mountain was in the eastern or near range, of very regular form, extending with the exception of this gap, for a distance of five and twenty miles without break. The crest of the range was of so regular a form, that no point could be selected as a peak, I therefore gave the whole the name of "Livingston's Range;" it is a very marked feature when seen from the forks of Belly River and the plain outside.

On leaving Belly River we rose considerably, and keeping along under Livingston's Range, the sun had dropped behind this great curtain before we camped. The spot was 540 feet above Belly River which we had left behind to the northward. Looking to the mountains ahead of us, I picked out the most prominent, and took bearings of them before the Indian who was in the rear hunting, came up. There were two near one another bearing thirty miles south, one of which, from the resemblance to a castle on its summit, I named "Castle Mountain;" to the east of these, but at a greater distance a portion of the mountains stretched out to the eastward. From reports which I had previously heard, I took the most easterly one standing by itself to be the "Chief's Mountain," which the Indian on coming up confirmed, and pointed out the place where on the morrow we should turn into the mountains.

This offset range occurs, as I afterwards discovered, just at the 49th parallel or International Boundary line.

The morning of the 20th of August was thick and hazy, with occasional showers of rain, which entirely prevented me from obtaining the good view of the country which I had hoped for, having seen but little in the uncertain light of the previous evening. I therefore travelled on, crossed Crow Nest River, and soon after noon gained the entrance of the Kootanie pass, where another of the branches of Belly River issues from the mountains. Here we struck a narrow but tolerably well beaten track, which the Indian informed us was the Kootanie trail, by which the Indians had crossed the mountains in the past spring. Making a turn therefore to the W.S.W., nearly at right angles to our former course, we followed this track which led up a narrow valley along the left bank of the river and between high wooded hills; the travelling was good, for we were on the even grassy river levels, and we camped at a spot where a small mountain stream entered the river from the north.

We were now fairly in the mountains, and had already overpassed the spot where our Indian guide knew anything of the road but by report; he knew that if all went right we should be some three or four days in crossing, and had been told that there was but one track, and that we were not likely to miss it. It may be asked why was I without a guide? The fact was, that a guide had been allotted to me by Capt. Palliser, but on leaving the camp of the expedition on Bow River, I had started without him on account of the sickness of his wife. He promised to start the following morning and overtake the party, which he failed to do. It will be seen subsequently, however, that I did not suffer by his absence, and I am now glad that he was not of the party, for I have no great faith in the so-called "guides," and think they are seldom worth their pay.

The entrance of this pass is in latitude 49° 34′ N., and longitude 114° 34′ W., being (consequently) forty English miles north of the Boundary line. I have omitted to insert the latitude and longitude of points where I obtained observations, because by referring to the map, the geographical position of any place may be seen.

We started at 5.40 in the morning with the sky overcast, and a drizzling rain, and soon entered thick woods and uneven ground, with a great many fallen trees, which caused the horses to travel slowly. We continued travelling in this way and gradually ascending along the course of a small creek running into Railway River, which we had left where the trail parted from it; this river was so named by me from the striking advantage offered by its "levels" for the entry of a railway into the mountains. Gradually the stream became less and less until after gaining considerable altitude it dwindled into a small quantity of water falling in a cascade. Here we passed Hero's Cliff, an enormous vertical escarpment, facing the east, of hard red sandstone or quartzite, with the strata dipping at least 45° to the west. We now rose rapidly as will be seen by reference to Section No. 1, (the Kootanie Pass); the trees became smaller, and we soon reached the region of rock and alpine plants; here were some large patches of snow and a couple of ponds of clear water; we passed over a quantity of debris of hard grey limestone of which the peaks on our right hand, namely, to the N.W., were composed. As we were now clear of all shelter, we felt the cold damp east wind, which blew a fresh breeze, and drove along scudding clouds which prevented any extensive view. We were now on the watershed of the mountains, the great axis of America; a few steps farther and I gave a loud shout as I caught the first glimpse, in a deep valley as it were at my feet, of a feeder of the Pacific Ocean. It was the Flathead River, a tributary of the Columbia. At the same moment the shots of my men's guns echoing among the rocks announced the passage of the first white man over the Kootanie Pass. I halted for the purpose of reading the barometer, which shewed an altitude of 5960 feet. It was just five hours since leaving our previous night's camp, at an altitude of 4100 feet.

This is no place for a dissertation on the physical geography of North America, but I may simply state, that in that portion of the Rocky Mountains, comprised between the parallels of 45° and 54° north latitude, rise the four great rivers of the continent, namely, the Mackenzie, running north to the Arctic Ocean, the Saskatchawan east to Hudson's Bay, the Columbia west to the Pacific, and the Missouri south to the Gulf of Mexico; thus we may say, that in a certain sense that portion of the mountains is the culminating point of North America, and I

now, on the Kootanie Pass, stood as nearly as possible in the centre of it.

A rapid descent of two hours brought us to the Flathead River, a clear and quick running stream, dividing a beautiful partially wooded valley enclosed by mountains; here we halted soon after mid-day, having passed the great watershed, and descended again 1400 feet without breakfast.

During Sunday I did not move from my pleasant camp, where was wood, good water, and good pasturage, everything to be desired by the traveller. I was engaged in obtaining observations for latitude and longitude, and computing them, writing up my notes, &c.; and I also made a sketch of the mountains over which we had passed the previous day. The men brought in some ducks, grouse and trout, which made an agreeable change in our diet; two or three humming birds were seen about the camp.

The track now led up to the course of Flathead River, through thick forests with occasional openings, crossing several mountain streams, feeders of the river. We halted for breakfast on an open piece of swampy ground. On moving forward again we plunged into thick forests, where the track was greatly obstructed by fallen timber. The Kootanies cut through a good many of the fallen sticks to allow of the passage of their horses, but still the greater number remain as they fall, and cause much twisting, turning, and branching of the track. We ascended gradually, passing a few fine pieces of open meadow, until we arrived near the head waters of the river, when the different streams composing it became mere mountain torrents. Here we commenced a steep ascent, the path ascending in a zig-zag up the hill; the trees, mostly spruce and fir, became smaller until we gained the summit of this knife-like ridge, from which an extensive view of the mountains was obtained. I halted to contemplate the scene, take bearings, and read the barometer, which shewed an altitude of 6100 feet. All appeared, however, utter confusion, such slight differences were there between the different mountains and ridges. One peak alone shewed itself above the general surface. It lay to the northward about thirty miles distant, and I recognized it as "Gould's Dome," which I had previously remarked from the edge of the plains. I estimated it to be not more than 1000 feet above my present position which would give it an altitude of about 7000 feet. The rest of the mountains appeared all about the same level, and but few of greater altitude than the ridge from which I surveyed them; there were visible the main range or watershed, then a number of ridges and mountains densely wooded, and of somewhat less elevation; after which, to the westward, higher mountains, the ranges generally taking a N.N.W. and S.S.E. direction. Such was the

scene to the north of my position, but to the southward the mountains appeared to have no general direction, as many running crosswise as lengthwise. I was now on a height of land between two branches of the Columbia; the rock was the same hard gray sandstone we had observed all along the base of the mountains on the east side, no granite showing itself anywhere.

Heavy dark clouds were gathering rapidly, and the louder and louder rumblings of thunder warned us of an approaching storm. We had descended but a few yards of the great western slope when the tempest broke with all its violence, and we were wet to the skin in a few moments; my own habiliments were far from waterproof, being simply a flannel shirt, a pair of leather trowsers, with a striped cotton shirt over all. The descent was very steep, the horses having in some places difficulty in keeping their legs, although the path was zig-zag; and the continual descending on foot was very trying to the legs. After some distance, however, the descent became less steep, and we continued our course for a couple of hours before coming to any place fit for camping. Although camping in the woods is always to be avoided with horses, we were at length induced to halt from the appearance of some old skeletons of Indian lodges, not knowing how far we might have to travel before coming to any open place; and we camped, for the first time, in a Columbian forest.

The change in the vegetation was first made evident to me on descending the mountain, by the appearance of a beautiful and regularly formed cedar, which for the sake of remembering the tree, I then called the "Columbian Cedar." It flourished at an altitude of about 5000 feet, and I subsequently observed it as low as 3000, but I feel doubtful as to whether it descends to the Tobacco Plains. Besides this I found, to me, a new *Abies* something like the Balsam Fir of the Atlantic slope, but with a rough bark, and growing to a large size; the Spruce and supposed Bank's Pine remained with a few Balsam Poplar and Birch, some of good size; also Maple and Alder as underwood. A new Larch appeared, an elegant tree; and around our camp were the dead stems of many deprived of life, no doubt in years past by fire, rising to an immense height, and tapering upwards perfectly straight, without a limb, to a fine point.

The next day we travelled on through these forests, continually descending, and before noon arrived at Wigwam River, where it passes between two high rocky hills, which, from their imposing appearance from this spot I called the North and South Bluffs. The bed of the river was deeply cut in the valley and exposed grand sand cliffs from two to three hundred feet in height, portions of these cliffs were broken, and pinnacles and blocks of different forms were left, having at a short distance a

most fantastic appearance. The track leaving the river and ascending a steep bank, carried us for five miles over a very rocky piece of country, where the trees were of stunted growth from want of soil, to the junction of Wigwam River with the Kootanie Fork of the Columbia. The former was forty yards wide and two to three feet deep, and the latter sixty yards across with a depth of four to six feet, both running with a swift current, their beds being rocky and stony. The Kootanie Fork could be seen coming down a valley from the N.N.W., from near a well marked mountain about twenty-seven miles distant, which has been called "The Steeples," or Mount Sabine. I believe that not far above the Wigwam tributary another called the Elk River comes in from the north, down a long narrow valley in the mountains. We descended about 300 feet, crossed the small river, and having lost the trail, camped for the night, the Indian's opinion being that we must also cross the main river, which would have occupied more time than the decreasing daylight would allow us. On going lower down the river in search of a better crossing place, I luckily struck on the proper trail leading up the side of the river bank towards the south; so we turned in that night with the satisfaction that we were still to travel in the morning on dry land.

To the west of us, on the other side of the river, was a level, partially wooded country, a portion of the Tobacco Plains, which as will be seen by reference to the plan, is a tract of country of about ten miles in width, stretching from near Mount Sabine on the north, to the southward of the Boundary Line, bounded on the west by low wooded hills, and skirting the feet of Galton's Range on the east. The Kootanie Fork in its southern course, after the entry of Wigwam River, traverses these plains.

Being now at the western extremity of the Kootanie Pass, I will pause to point out the capabilities it affords for a railway across the mountains within the British possessions. I should premise that I have not sufficient evidence to be able to state that the Kootanie Pass is absolutely the most advantageous place for the crossing of a railroad from the Saskatchawan Plains to the Pacific, because the mountains to the north have not yet been sufficiently explored; but I am able to say that it is the most southern line within the British territory, and, as yet, by far the shortest; moreover, I have every reason to believe, that the most suitable portion of the mountains for the passage of a railroad will be found to the south of Bow River.

The Kootanie Pass crosses the Rocky Mountains from the Great Saskatchawan Plains on the east, to the Tobacco Plains on the west, its extremity on the former side being forty, and on the latter, eighteen English miles, to the northward of the International Boundary, the 49th parallel of north latitude. Its

length is 40 geographical, or nearly 47 English miles, extending from longitude 114° 34′ to 115° 24′ W. It leaves the Saskatchawan Plains where they have an altitude of about 4000 feet above the sea, rises 2000 feet to the watershed of the mountains, descends to Flathead River, again to an altitude of 4000, follows up this river to its head waters, then crosses a precipitous ridge, reaching an altitude of 6000 feet; it then descends the great western slope, falling 2000 feet in two miles of horizontal distance, after which, by a nearly uniform grade of 100 feet per geographical mile, it gains the Tobacco Plains at the point where the Wigwam branch enters Kootanie River.

By reference to section No. 1, it will be seen that there are three obstacles to the passage of a railroad; namely, two mountains and one steep slope. As to the mountains, they could, I consider, without difficulty be pierced by tunnels; the great western slope is a more serious obstacle; however, in the following details I hope to show that it also may be overcome.

From the forks of Belly River on the east side, the line would traverse the gradually ascending prairie to the entrance of the pass where Railway River issues from the mountains. This river would be followed up with a grade of 1 in 180, or 34 feet per geographical mile for 7½ miles, the "river levels" affording considerable advantages; leaving this river it would follow the course of my track marked on the map. A cutting of about 3½ miles would lead to a tunnel of nearly five miles in length, which would pierce the Watershed mountain, and come out in the valley of Flathead River, the whole having a grade of 1 in 130, or 47 feet per geographical mile. On emerging into the valley, the line would skirt the base of the mountains to the north of the track, thereby avoiding a steep descent, then following up the river with a grade of 40 feet per geographical mile it would reach the rise of the western ridge, at a height of 5,100 feet above the sea. This would be the culminating point of the line, from which in a distance of ten geographical miles, it has to fall 1,900 feet to the North and South Bluff, and after that, by a slope of 54 feet per geographical mile for five miles to reach the Tobacco Plains, crossing the Kootanie Fork by a bridge. This I propose to accomplish in the following manner. From the culminating point, to pierce the ridge by a tunnel of three geographical miles, and continue the line along the side of the hills to the north of the track, until reaching the North Bluff, the whole with a grade of 190 feet per geographical mile. This portion of the line of ten geographical miles, would have to be worked by a wire rope, and one or more stationary engines. Regarding the remaining five miles to the west of the North and South Bluffs, a careful survey is required to determine whether a grade not too steep for locomotives can be made. My meas-

urements, taken with so uncertain an instrument as an aneroid barometer, must not be depended on to a few feet; they give a fall of 54 feet per geographical mile, or 1 in 112.

As regards the country to the west of Kootanie Fork, I can say nothing, but that no mountains were visible to the distance I could see; neither have I any personal knowledge of the Saskatchawan Plains to the eastward of the forks of Belly River. But it is probable that these great prairies stretch without break from this point to the Red River settlement, and that in the construction of a railroad, little more labor would be required than that of laying down the rails. The following statement of distances to be traversed by a railroad to the Pacific within the British territories may be of interest:—

	Geog. miles.
Lake Superior to Red River settlement, - - -	320
Red River settlement, *viâ* elbow of south branch of Saskatchawan to Rocky Mountains, - - -	700
Kootanie Pass, - - - - - - - -	40
West end of Kootanie Pass to mouth of Frazer's River, Gulf of Georgia, - - - - -	300
Total, Lake Superior to Pacific, - -	1360

Probable length of railroad, 2300 English miles.

Thus it will be seen that out of the whole distance one-half is over level prairies, and but 40 miles through mountains.

To resume the narrative of my journey: On the morning of the 25th of August, at starting we were obliged to climb the face of a steep hill-side for the purpose of keeping on the left bank of the Kootanie Fork, which here sweeps in close under an outer range of the mountains, having a north and south direction, and which I have called "Galton's Range." We gained a considerable altitude above the river, which ran at our feet, and of whose course I had a view for some distance. The banks were vertical and rocky, and the stream appeared to continue swift. Both horses and men had enough to do in climbing up, and then coming down again from the heights. I was well repaid for my climb by the remainder of the day's travel, which was through magnificent open forests with patches of prairie, sometimes of considerable extent. These forests were the finest it had been my good fortune to see. A splendid species of pine and the larch previously spoken of, with their bright red barks, rose from the ground at ample distances; no brushwood encumbered their feet or offered impediment to the progress of wagons, which might move in every direction.

As we advanced along the prairie the trail forked, and our Indian took the branch which led nearest the river, as from information he had received, he believed it to be that which led to the trading post. Towards evening, according to my reckon-

ing, we crossed the Boundary Line, and camped about two miles within the American territory, and not more than a mile from the river. In a few minutes, a Kootanie Indian came to us on horseback. My Indian guide "James," knowing but a few words of his language, and a little Blackfoot, and he not knowing one word of Cree, we had some difficulty in comprehending that he wished to inform us that there were no people at the trading post, which he described as being quite close. A small present of tobacco and something to eat were thankfully received by him, and he took his leave. Shortly after there came several more from the same camp, having a chief among them. They were mounted on good looking horses, and raced up to our camp as hard as they could gallop, no doubt with the idea of creating an impression. The evening was spent in a talk with them, one of them understanding Blackfoot. It was dark before they took their departure, having promised that they would meet us in the morning at the trading post, to guide us to their camp, where they wished us much to come, saying they had some provisions.

Following the track still S.S.W. the following morning in a thick fog, we came on the river, and within a few hundred yards found three diminutive log houses. Two of them, not over ten feet square, had evidently been used for dwellings, and to enter them it was necessary to crawl through a hole as an apology for a door; the other, somewhat larger, without a chimney, we were informed was the Kootanie chapel which had been erected the previous spring when a priest was there.

The Kootanies afterwards informed me that white people always come in the fall, remaining for the winter trading with them, and returning to Colville, eight or ten days' journey, in the spring. These are the Hudson's Bay Company's people, and this post is the same that figures on maps in large letters as "Fort Kootanie." I remained here till noon, and obtained observations, which placed the post in latitude 48° 55′·5 N., and longitude 115° 31′ W., thus a little over five English miles south of the Boundary.

In the afternoon I rode four miles across prairie in an easterly direction with a chief, the pack animals following, and arrived at the Kootanie Camp, where I was under the necessity of shaking hands with every man, woman and child. The people had a rather dirty and wretched appearance, but their herds of horses, and some few horned cattle, showed that they were not poor.

Having pitched my tent at a short distance from the lodges of the Indians, which were in a pleasant situation near a small stream with some woods along it at the base of Galton's Range, I was soon inundated with presents of berries dried and fresh, dried and pounded meat, and cow's milk. Of course, although no payment was asked, I paid these people for their food in tobacco, ammunition, &c.

Seeing that there was no chance of starving, I determined on remaining here some days for the sake of the horses; the next five days were therefore spent in trading, and exchanging horses, buying provisions, &c., and obtaining by actual observation and Indian report, such knowledge of the country as I was enabled to do.

The weather was fine, and generally calm, but rather warm, the thermometer ranging from 47° to 82° in the shade. I should have said, that in my passage over the mountains, I had experienced no cold nights, the temperature at sunrise being usually about 50°, once only so low as 37°.

I made an excursion to the north of the boundary with my sextant, to obtain as near as possible the precise position of the line; I found no remarkable feature to mark it, but noted the place where it crossed the hills. I also obtained a sketch of the mountains to the northward, Mount Sabine, or as I had myself named it from its peculiar form, "The Steeples," standing out quite distinct from the rest. I may here say, that it was in the neighborhood of this mountain, that Capt. Palliser, following the old Emigrant Pass which he had entered at Bow river, emerged from the mountains after a six or eight days' journey; he then, without however coming to the mouth of the Wigwam branch of the Kootanie river, the true entrance of the pass, recrossed by the Kootanie Pass, which I had previously explored.

I found the Kootanies communicative, and from them gathered the following information:—

That Colville, an American settlement on the Columbia, was about eight or ten days' journey with pack horses, and that they could descend to it by the river in canoes, but there were too many falls and rapids to admit of its being ascended; that the Flathead River, which I followed up in the mountains, runs to the south and joins Clark's Fork of the Columbia, in which is the Flathead Mission, which they described as three days' riding south of this; that there are large lakes to the northwest of the Kootanie Post, from one of which a small river flows and joins the Kootanie Fork, before it falls into Clark's Fork.

They also told me that there was a pass entering the mountains a little to the southward of their camp, and which came out on the east side near the Chief's Mountain; that there were long hills, but not so steep as the Kootanie Pass, and that they used it sometimes when the horses were heavily loaded. This information of another pass in a portion of the mountains that I knew should be explored, caused me at once to decide on recrossing the mountains by this pass, although I knew that it must be wholly or partially on American ground, I therefore prevailed upon a Kootanie to accompany the party across as guide.

There are some considerable tracts of the Tobacco Plains which are prairie; the grass however, does not grow close and thick, but in small bunches with bare ground between, and the pasture is nothing to be compared to that at the base of the mountains on the east side. This is perhaps chiefly owing to the nature of the soil, which in the latter case, is a black mould, while on the Tobacco Plains it is sandy, and in most parts stony; at this season the grass was quite dried up and yellow.

As to the Kootanie Indians, their language at once strikes one as being most guttural and unpronounceable by a European, every word appearing to be brought up with difficulty from their lowest extremities.

They are nearly all baptized Roman Catholics, and are most particular in their attendance at morning and evening prayers, to which they are summoned by a small hand-bell. They always pray before eating. On the Sunday that I spent with them, their service, in which is a good deal of singing, lasted a considerable time; one of their number preached, and seemed to be well attended to.

Their food at this season appears to be almost entirely berries, namely, the "Sasketoom" of the Crees, a delicious fruit, and a small species of cherry; also a sweet root, which they obtain to the southward.

They grow some little wheat, and a few peas; a patch of the former, about forty yards square, which I saw near their camp, although rather small headed, looked well, a proof that this grain thrives in latitude 49° at an altitude of 2500 feet above the sea.

They possess more horses than any Indians I have seen or heard of on the east side, a camp of only six tents, having about 150, old and young. They also, in their treatment, are kind to, and show some knowledge of the animal. They are adepts at throwing the lasso, being brought up from their youth to its use. They possess a certain amount of domestic cattle, six tents having twelve or sixteen head; and I heard of some individuals at a distant camp, who owned as many as twenty or thirty each.

They are perfectly honest, and do not beg, qualities which I have never before met with in any Indians. I extract the following from my journal, written on the spot:—"On taking leave of the Kootanies, with whom I have been camped for nearly a week, it is but justice to say, that they have behaved in a very civil and hospitable manner, and although our clothes and other articles have been lying about in all directions, we have (with the exception of some hide lines, moccasins, and other articles of leather, which the half-starved dogs have eaten) not lost a single article." Whether this honesty is to be attributed to the knowledge of christianity spread among them by the ministers of the

Roman Catholic church, or whether it is innate in them, I can only say that it is a great contrast to the effect produced by the missions in the Indian territory on the east side.

The Tobacco Plains form the country of the Kootanies, but every spring and fall they cross the mountains to the Saskatchawan Plains for the purpose of killing buffalo; they return with supplies of dried meat, &c., with which they trade for blankets, knives, tobacco, &c., with the Hudson's Bay Company's traders at the Kootanie Post. They also sometimes cross during the latter part of winter, when there is sufficient crust on the deep snow of the mountains, on snow shoes, also for the purpose of obtaining provisions, for there is little or no game on the west side.

On the 2d of September, I set out on my return journey across the mountains. The morning was clear and sharp, the thermometer being two degrees below freezing. After I had lost sight of the Kootanie camp, and was riding ahead of my party on a S.S.E. course over undulating prairie, I felt satisfied that I had done all that came under the spirit of my instructions, and was happy to be able to recross the mountains by another unexplored route; my only regret was that this time it was not my fate to see the Pacific.

Leaving the Tobacco Plains at a point where they were pretty thickly wooded we followed a narrow trail, which, turning the south end of Galton's Range, followed up a small creek towards the north end. We crossed a considerable mountain stream coming down a valley from the north, which as it may be of use to the Boundary Commission, I have taken care to mark, and camped at an altitude of 4070 feet. The following day we crossed, soon after starting, some high land, and then descended for the remainder of the day through thick woods till we arrived in the valley of Flathead River. The day after we descended by successive steps to the Flathead River, where it is joined by a creek from the N.W., here I remained till noon for the purpose of fixing the position of this part of the river, which was just 25 miles south of where I had fallen upon it in my progress westward. Several peaks of the mountains showed well from this valley, and I did not lose the opportunity of sketching. A storm coming on drove me to camp earlier than I had intended. We halted on the creek spoken of, and only about half a mile south of the boundary, which according to careful bearings, crosses just over a mountain, which itself has its length nearly in the exact direction of the line. Much rain fell in the afternoon and by the next morning, Sunday, had changed for snow which continued nearly all that day, giving the mountains a good white coat.

On Monday the 6th of September, immediately on starting at 6 A. M. we regained British ground; we travelled up the creek till 10, when we halted for breakfast. It was cold, raw, and clouded. Here we found that the Kootanies, four men and two women, with whom we were travelling, and who had camped here on Saturday, had started this morning for the traverse of the mountains. Suspecting that we had a good days' work before us, I delayed as little as possible at breakfast, and in less than an hour and a half we were again under weigh travelling up the course of the creek, which has some picturesque falls and cascades, caused by the inclined strata of red shale and sandstone. After two or three miles we began a steep ascent, and were soon on ground entirely covered with snow, in which the tracks of the Kootanies who had gone before us were visible. We passed along the edge of a very steep hill, and it was as much as the horses or ourselves could do in some places to keep footing. We now descended, crossed a thickly wooded gully and then commenced the ascent to the water-shed, through thick wood. The snow increased in depth as we ascended, until on arriving at the crest it was two feet on the level, and in places heaped up to double that depth. It was cold work trudging through the snow in thin leather moccasins without socks; and to make matters worse it was blowing and snowing all the time. I however on arriving at the water-shed, with the assistance of the Indian "James," whom I always found most willing, unpacked the horse with the instrument boxes and obtained a reading of the barometer, which gave an altitude of 6030 feet. We ascended *along* the ridge about 100 feet more, and then by a zigzag track commenced a steep descent. It was not however very bad, and we soon arrived at a small mountain torrent flowing eastward, thus regaining the waters of the Atlantic after an absence of sixteen days. The trail continued mostly through woods down the valley due east. The rocks on the tops of the mountains on either side were often of very curious shapes, and the strata in places much contorted; there were also some magnificent cliffs, and the cascades of snow water falling down the narrow gullies, added motion to the grandeur of the scene. The snow gradually decreased as we descended. On arriving at the spot where the valley joined another, I found the Indians camped on a patch of prairie, where I was glad enough to let my horse free, as we had travelled this day from six to six, with a halt of only 1½ hours.

The horses had the first half of the following day to rest, and I took the opportunity of testing my aneroid barometer by the boiling water apparatus, making the ordinary observations, and taking a sketch of a very peculiar peak just above our camp. After two hours travelling on level ground along Red-stone

Creek, we emerged on the Saskatchawan Plains, just six geographical miles north of the 49th parallel, and camped at Waterton Lakes two miles east of the mouth of the pass.

The position of the Waterton Lakes, as will be seen on the plan, is just where the offset range, before spoken of, strikes out to the eastward from the main chain, having the Chief's Mountain at its extremity. The uppermost and largest of these lakes, lies in a gorge in the mountains, and is crossed by the boundary line; the scenery here is grand and picturesque, and I took care to make a sketch from the narrows between the upper or southernmost and second lake.

I was here fortunate enough to discover a stunted species of pine which M. Bourgeau, the botanist of the expedition, had not obtained. I gave him the specimen of this as well as of some ferns and other plants which I had collected.

I was much struck by the comparative greenness of the prairies on this side, after the burned-up appearance of the Tobacco Plains, which we had left but a few days before.

I remained camped at this pleasant spot two whole days for the sake of the horses, and in order to examine more carefully the nature of the country. Game was abundant, including grizzly bears, and we obtained both fresh meat and fish. The trout and pike in the lakes were of large size.

The Chief's Mountain was not visible from the camp, but I obtained a good view of it from a knoll on the prairie about four miles distant, which with my previous bearings enabled me to lay it down, and curious enough, the boundary line passes just over this peculiar shaped mountain, which stands out in the plain like a landmark. I also made a sketch of it.

It will be seen that some of the waters of the Saskatchawan take their rise from the offset range at the boundary line, and from information gained from the Indians, I believe there is a tributary of the South Branch, which rises to the southward of the Chief's Mountain, this may be the Bull-pound River of Arrowsmith; if so, this offset range has nothing to do with dividing the waters of the Missouri and Saskatchawan, and some of the waters of the latter must come from American ground.

We experienced a gale of wind from the southwest, on the night of the 7th, which on the following morning ceased very suddenly, and an opposing wind from the north brought rain and snow, which gave another coating of white to the mountains. This corner of the mountains appeared to be a very windy spot, and when it was not blowing much on the plain, a strong breeze came from the south down the gorge in which is the upper Waterton Lake.

On the 10th of September, I turned my face towards Fort Edmonton, the previously appointed winter quarters of the expedi-

tion, which lay more than three hundred miles to the north, and as will be seen on the plan, passed several creeks, and over a country mostly prairie. I remained at the Forks of Belly River on Sunday the 12th. From this place I visited a camp of forty-five tents of Blackfoot Indians, accompanied by one of my men, and "James," the Cree Indian. I was received with the usual hospitality, and having expressed a desire to change a horse or two, I had no trouble the following morning in exchanging one and buying another for ammunition, tobacco, blankets, old coat, &c. This tribe has the credit of being dangerous, but from what I have seen of them, I consider them far better behaved than their more civilized neighbors, the Crees. I made it a rule never to hide from Indians, and, although I had but a small party, to go to them as soon as I knew of their proximity. I also always told them for what reason the British Government had sent the expedition to the country; and I never failed to receive manifestations of good will, neither was there one attempt made to steal my horses, a practice only too prevalent among the Indians of these plains.

I need not describe my northward journey; suffice it to say that I kept to the east of my former track, along the base of the mountains, except when I turned in for the purpose of raising the cache. I rested at Bow River on Sunday the 19th, travelled over prairie till crossing Red Deer River, the other fork of the south branch of the Saskatchawan, on the 23d; then, passing through a partially wooded country, which I had surveyed in the summer, arrived at Fort Edmonton on the north branch, on the 29th of September.

In this account of the return passage of the Rocky Mountains, by what I have called the Boundary Pass, I have not entered into such details as in the case of the Kootanie Pass, because, as will be seen by the accompanying plan and sections, more than one-half of it lies in American ground; but I have given the same amount of attention to the mapping of it, as I considered a knowledge of that portion of the mountains would be of service to the International Boundary Commissioners at present engaged on the west side. Moreover, I do not consider the Boundary Pass so well suited for the passage of a railroad as the Kootanie Pass.

It will be perhaps noticed that I have said nothing concerning the fitness of the Kootanie Pass for a waggon road. My reason is simply that where a railroad can be constructed, a waggon road can also be made; without considerable expense a road could not be made to pass *over* the two high points, (through which a railroad would tunnel,) in the line of the pack-horse track followed by me; but I have no doubt by taking more circuitous routes, both of these heights might be passed by slopes

adapted for wheel carriages. In other parts the road would follow the line proposed for the railroad.

I have not mentioned the existence of two other passes across this portion of the mountains, called the "Crow-nest" and "Flathead Passes," the former in the British, and the latter in American territory.

The Crow-nest Pass, of which I have marked the general direction on the plan, follows up Crow-nest River, a tributary of Belly River, into the mountains, and gains the west side near "The Steeples." By report of the natives it is a very bad road, and seldom used. I observed the old trail coming in from the plains on the left bank of Crow-nest River.

The Flathead Pass enters the mountains at the 49th parallel of latitude, follows the west shore of Lake Waterton, and gains Flathead River, which it follows to the Flathead Mission on Clark's Fork of the Columbia, about 80 miles S. by E. of the Kootanie trading post. It is used by the Flathead Indians when crossing to the Saskatchawan Plains for the purpose of obtaining buffalo meat.

Fort Carlton, Saskatchawan River, December 15, 1858.

APPENDIX.

[Extract from the address of Sir R. I. Murchison at the anniversary meeting of the Royal Geographical Society, May 23, 1859. p. 103.]

Palliser Expedition.

British North America.—The important results of the exploring expedition under Captain J. Palliser, as communicated by the Colonial Office, and as dwelt upon in awarding the Founder's Gold Medal to that officer, have necessarily given great satisfaction to us, proceeding as they do from men who were especially recommended for this public service to Her Majesty's Government by our Society as well as by the Royal Society.

When Captain Palliser first proposed to make this exploration, one of the main points of interest to geographers was a survey of that part of the Rocky Mountains to the north of the United States boundary which separates the great tracts now named British Columbia from the eastern mass of British North America. Her Majesty's Government deemed it, however, of paramount importance that, in the first instance, the nature of the ground between Lakes Superior and Winnipeg should be accurately surveyed, in order to set at rest all questions of colonization as dependant on the possibility of making practicable routes of communication. For example, whether the Canadas might be brought into profitable communication with the Red River Settlement. The remoter or more western explorations were destined to develop the true nature of the great prairie

region, as watered by the North and South Saskatchawan rivers and their affluents. Collaterally, it was resolved, if possible—and mainly at the instance of this Society—to determine the elevation of the Rocky Mountains in those parallels of latitude, and to point out the passes in them by which communication might be opened out between the vast country occupied by the Hudson Bay Company and the great British seaboard on the Pacific.

In the award of the Patron's Medal to Captain Palliser, allusions have been made to some of the principle results obtained by the researches of the expedition under his orders. But I should not do justice to the leader and his associates, nor to my own feelings, were I not to add a few words of explanation and comment. The first year's labors were necessarily of more importance to the Government than they could be to geographers and naturalists. The great object was to determine the capability of establishing an intercourse between the rocky region of Lakes Superior and Winnipeg on the east and the rich prairie countries on the west; and though astronomical, physical, and magnetical observations of considerable importance were made —these countries being to a great extent known before, and their outlines being monotonous—that portion of the survey created but slight interest among us.

Not so when the Rocky Mountains, to which we had specially directed attention, came to be surveyed.* On proceeding from Fort Carlton, Palliser showed his good sense in approaching these mountains from the rich Buffalo prairies midway between the North and South Saskatchawan. An experienced buffalo-hunter himself, he knew that if his men were not well supplied, by no efforts, however well directed, could they succeed. Accordingly, having established a good base, and having secured abundant provisions at Slauter Creek, he divided his force into three parties. Leading one of these himself across the Kananaski Pass, and returning by the Kootanie Pass in north latitude 49½°, and directing Captain Blakiston to explore the still more southerly or boundary Pass, he sent Dr. Hector to traverse the chain by the Vermilion Pass, and to explore, as a geologist and naturalist, the much loftier mountains into which the chain rises in its trend to the N.N.W. This division of his forces well merited, therefore, the expressions used in the award which has been sanctioned by the Council.

The marked success of the survey accomplished by my young friend Dr. Hector has been peculiarly gratifying to me, inasmuch as I had answered for the capacity he would exhibit in applying his scientific knowledge. Thus, in addition to the determination of latitude, longitude, and the altitude of the mountains and two

* Dr. Hector had, by directions of his chief, made a successful foray in dog sledges to the eastern edge of the Rocky Mountains during the winter, in which he procured men and horses.

of their passes, Dr. Hector presents us with a sketch of the physical and geological structure of the chain, with its axis of slaty subcrystalline rocks, overlaid by limestones of Devonian and Carboniferous age, and flanked on the eastern face by Carboniferous sandstone, representing, probably, our own coalfields, the whole followed by those Cretaceous and Tertiary deposits which constitute the subsoil of the vast and rich prairies watered by the North and South Saskatchawan and their affluents. His observations on the erratic or drift phenomena are also curious and valuable.

Prevented by his instructions from descending into the valleys of Columbia, and there to ascertain practicable routes to the far west, which he will look out for during the present summer, Dr. Hector, though so severely injured by the kick of a horse as to be incapacitated from moving for some days, contrived so to travel northwards as to round the base of the loftiest mountains of the chain before he returned to his winter-quarters in October, after an absence of eighteen weeks from his chief, but laden with valuable geographical and geological knowledge.

In this survey he had the merit of showing that the Vermilion Pass—which is less than 5000 feet high, and therefore 1000 feet lower than any other known pass of the Rocky Mountains—had another decided advantage over them, inasmuch as its western slope, from the summit level of the horse-path, is so little steep that its explorer has no doubt that even a road for carts may be there established. The descents westward, or into the drainage of the Columbia, in the other passes are exceedingly steep; and according to Captain Blakiston, the Kootanie Pass can only have a railroad made along it by the formation of tunnels of several miles in length, and by encountering the difficulty of the steep western gradient of 194 feet per mile.

Another singular natural feature of comparison is, that whilst the Vermilion Pass is less that 5000 feet above the sea, the adjacent mountains on the north rise to near 16,000 feet, showing the great depth of the gorge. On the other hand, in the range beyond the British boundary, to the south, and where no peak (not even that of Fremont) exceeds 13,000 feet, the passes range from 6000 to 7000 feet high.*

* In anticipation of what may hereafter be published in the 'Journal of the Royal Geographical Society,' the reader is refered to the papers presented to Parliament in April, relative to the "Exploration by Captain Palliser of that portion of British North America which lies between the northern branch of the River Saskatchawan and the frontier of the United States, and between the Red River and Rocky Mountains." These printed documents are accompanied by a map, executed by Arrowsmith, from the surveys of the Palliser expedition, together with despatches of the leader and officers under his command, and tables giving the calculations of latitude and longitude by which the positions of places were fixed. An additional paper and map on the southern part of the Rocky Mountains near the American boundary, as prepared by Captain Blakiston, who had quitted the expedition, has very recently been sent to the Society, with the notice from the Secretary of the

Whether one of the heights called Mounts Brown* and Hooker by Mr. Douglas, in honour of our eminent botanical contemporaries, be still higher than the Mount Murchison of Palliser and Hector, it is certain that the chain diminishes rapidly in its trend from this lofty cluster to the north. We know, indeed, that Mackenzie, the first great explorer of those regions, passed through the range in north latitude 56°, at a comparatively lower level. Again, we further know that in proceeding northwards these mountains dwindle into insignificance before they reach the Arctic Ocean.

It will be recollected that seven years ago Captain M. H. Synge of the Royal Engineers, who had been quartered in the Canadas and had made excursions into the adjacent western territories, being deeply imbued with the importance of the original observations of Mackenzie, and attracted by his glowing description, made a warm appeal in favor of the establishment of a line of communication between the Atlantic and Pacific, by passing from Lake Athabasca and the Peace River, thence traversing the Rocky Mountains on the parallel followed by Mackenzie. But that scheme must now, I apprehend, give way before the

Colonies that it was not to to be looked upon as an official communication until sanctioned by Captain Palliser.† These last-mentioned documents, which seem to me to be also ably prepared, have not yet been laid before the Society. The public will soon possess an excellent map by Arrowsmith, in which all the new discoveries are inserted. This map is entitled 'The Provinces of British Columbia, Vancouver Island, with portions of the United States and Hudson Bay Territories.'

I was recently informed by my friend the Right Hon. Edward Ellice that the geographical position of these passes was laid down many years ago upon a MS. map, at the instance of the Hudson Bay Company, by Mr. David Thompson. I have further learnt from Mr. Arrowsmith, with whom he corresponded, that Mr. Thompson explored the vast regions of the Hudson Bay Company in all directions during twenty-eight years, and projected the construction of a general map of the whole country between Hudson Bay and Lake Suprior on the east, and the Pacific on the west! It appears that the last six years of his labors were spent on the west side of the Rocky Mountains; it being important to note that his MS. maps were all made from actual survey, corrected by numerous astronomical observations. The largest affluent of the Frazer River in British Columbia, "the Thompson," justly bears the name of this great but little-known geographical explorer; and I therefore trust that there is no foundation for a report which has been spread, that it is proposed to substitute some other appellation for the name of this meritorious man. Beginning his astronomical observations in 1792, Mr. David Thompson was in 1817 appointed the Astronomer of the North American Boundary Commission, and was upwards of eighty years of age when he died in Canada. In the words of Mr. Arrowsmith, "he has left no one behind him who is possessed of a tenth part of his acquaintance with the territories of the Hudson Bay Company, whose directors were duly sensible of his great merits." Whatever may be the fate of that remarkable Corporation, we must all admit that it has not only maintained British rights over wide tracts of North America, but has also, in addition to Thompson, produced some of the best geographical explorers of snow-clad Arctic countries, including our medallist Rae; whilst its dealing with the various fur-hunting tribes of Indians have been so equitable as to have maintained the attachment of these poor people, who under such influence have been preserved, instead of falling before the white man as in other parts of America.

* Mount Brown is said to be 16,000 feet high.

† This is the preceding Report.

shorter passages across the mountains in a more southern parallel, and which will, it is hoped, bring a rich prairie country on the east into intercourse with our newly-discovered gold region on the west, as well as with Vancouver Island, the natural resources of which were brought before us by Colonel W. C. Grant. During the animated discussion which took place among us in the year 1851, Mr. Asa Whitney, of the United States, in proposing his gigantic plan of an inter-oceanic railway, candidly told us that the best line of intercourse between the two oceans would be found within the British territories, and the Palliser expedition has already gone far to demonstrate the truth and value of his suggestion.

With a knowledge of the data acquired by the Palliser expedition, men of ardent minds already contemplate the formation of a railroad, or, if not, of a practicable route, which traversing British possessions only, shall connect the Atlantic and Pacific Oceans. But when we reflect that the length of this line is above 2000 English miles, and that the greater part of the route on the east will have to traverse wild and unpeopled regions, we cannot rush to hasty conclusions as to the practicability of such an enterprise. Neither ought we to deride a plan which may be ultimately called for when British Columbia and Vancouver Island shall have risen into that importance which they must attain as British Colonies. For, it is now ascertained, that the tract lying between the North and South Saskatchawan on the east is one of great fertility, where no intense cold prevails, and that, once through the Rocky Mountains, the traveller enters a country of cedars and rich vegetation, in which even wheat may be grown at heights exceeding 2000 feet above the sea. In the mean time we need, at all events, have no hesitation in assuming that the electric telegraph will, ere long, be at work across British North America.

Believing it to be of the deepest geographical importance, that men who have distinguished themselves as Palliser and his associates, should not, through a misplaced economy, be held to their original instructions, and be forced to return homewards by retracing their steps from Fort Edmonton, over the previouly beaten tracts of North America and the United States, I have had great pleasure in supporting the request of the gallant leader of this expedition and of his associate Dr. Hector, that they might be allowed to wend their way home next summer by again traversing the passes in the Rocky Mountains, and thence to explore the great intervening tracts of British Columbia, including the auriferous region of Frazer River. I am happy to say that Sir Edward B. Lytton readily complied with this request, and that the Palliser expedition is thus about to establish fresh claims upon our approbation.

ART. XXXVI.—*On Nitride of Zirconium;* by J. W. MALLET, Prof. Chemistry in the University of Alabama.

(Read before the Amer. Assoc. for the Adv. of Science, August, 1859.)

AMONG the most interesting facts brought to light by the recent researches of Wöhler and Deville upon silicon and the allied elements is that of the strong affinity of these bodies, when free, for nitrogen. Several of the nitrides which result from this affinity have been described—as those of boron, silicon, titanium, and tantalum. I have now to add to the list *nitride of zirconium.*

This substance was obtained under the following circumstances. The ease with which silicon and boron may be crystallized by exposing the elements in the amorphous state to a very high temperature, in contact with aluminum, which when fused seems to act the part of a solvent, led very obviously to the expectation that other related elements might also be obtained in crystals by this process. Titanium and zirconium suggested themselves as specially worthy of experiment in this direction. With the exception of the bare notice* that Deville, by heating aluminum in a porcelain tube traversed by a mixed current of hydrogen and a vaporized chlorid, had obtained crystalline silicon, boron, carbon, *zirconium*, and *titanium*, I have seen no account of the preparation or properties of the last two. Deville and Wöhler have indeed stated at a beginning of a paper† on nitride of titanium that this substance was first noticed by them in the attempt to procure titanium itself in a compact state—but the means proposed for the attainment of the latter object are not mentioned.

A quantity of amorphous zirconium and titanium was prepared by heating the potassio-fluorids with sodium in an atmosphere of hydrogen, and it then remained to be seen whether the metals could be brought into the crystalline state by exposure to intense heat in contact with aluminum. A small piece of aluminum was placed in the cavity of a lime crucible (of the kinds proposed by Deville), and was then surrounded with black pulverulent zirconium, which latter was pressed down as closely as possible, and covered by a layer of quick-lime in powder, also strongly pressed. A stopper of solid lime was fitted to the opening, and the whole was exposed for about an hour to the heat of a small blast furnace capable of melting platinum.

After cooling, the crucible was removed from the furnace, and was found to be *slightly cracked.* This no doubt occurred at the beginning of the experiment, and was caused by the too

* Paris correspondence in Amer. Jour. Sci., May, 1856, p. 404.
† Ann. d. Chem. u. Pharm., August, 1857, S. 230.

rapid application of the blast. On breaking the crucible across, the interior presented the appearance of a porous mass of dark gray color, through which globules of aluminum were scattered. This mass was placed in dilute muriatic acid, and began in part to dissolve with effervescence.

A few iron-black shining scales, like those of graphitic silicon, separated out, and these perhaps constituted the original object of the experiment—that is, were zirconium in the form corresponding to graphite. The color and lustre were very like those of silicon in this form; the scales appeared however to be thin and flat rather than needle-like; no definite angles or planes could be seen under a high microscopic power. In another experiment these scales were obtained in larger proportion, excluding, I think, the likelihood of their being silicon itself, derived either from the aluminum or the lime; the absolute amount, however, was very small, and no chemical examination of these scales could be made.

As the acid continued to act upon the mass taken from the crucible, bright surfaces and little veins of golden color and lustre made their appearance, and here crystalline structure became apparent under a common pocket-lens. It was necessary, however, to use a pretty high microscopic power in order to bring out the form of the very minute specks which formed these gold-like crusts; with a magnifying power of 400–600 they were seen to consist of distinct cubes, the largest of which were not more than the one-hundredth of a millimetre on the side. The color and lustre were those of gold, and the appearance of some of the microscopic specimens was very beautiful, the little cubes being imbedded in a colorless glassy matrix, probably a compound of zirconia and lime. One was reminded by them of the titanium cubes of the iron smelting furnaces.

This gold-colored substance was but very slightly acted on by the common acids, even the nitro-muriatic, or by the alkalies in solution; fused with caustic potash it gave off ammonia in abundance, thus proving the presence of nitrogen. Its composition was not determined quantitatively, owing to want of sufficient material, for much of the zirconium had combined with the oxygen of the air, but a part uniting to the nitrogen. The nitride in contact with water at common temperatures, appeared to undergo in some slight degree the same decomposition that Deville and Wöhler* have remarked in the case of nitride of silicon, ammonia being formed.

It having been shown that zirconium is capable of uniting directly with the free nitrogen of the air, one or two experiments were made with gaseous compounds of nitrogen.

* Ann. d. Chem. u. Pharm., Mai, 1859, S. 249.

Amorphous zirconium was heated in a Bohemian glass tube up to the temperature at which the latter softened, a stream of ammoniacal gas being passed through it. At a low red heat there suddenly appeared a bright glow, spreading rapidly over the metallic powder, and then disappearing; this was probably owing to the presence of a little hydrate of zirconia, the water of which, as Berzelius has shown, yields oxygen to the metal when heated. After cooling, the tube was found to contain a dark gray, perfectly amorphous powder. Under the microscope it could be seen that the gray color was due to a mixture of white and black particles; the white being no doubt zirconia, produced partly by the presence of hydrate as just noticed, and partly by the fact that the ammonia had not been perfectly dried. The gray powder was gently heated in the air to drive off any free ammonia, and then fused with caustic potash; it gave off ammonia in abundance. Heated to low redness in the air, it took fire, glowed brightly, and even continued to burn when removed from the lamp-flame. It burned almost white, and when afterwards fused with caustic potash, gave only traces of ammonia.

A similar amorphous gray powder was obtained by heating the anhydrous chlorid of zirconium in gaseous ammonia, chlorid of ammonium and hydrochloric acid volatilizing. Unfortunately the ammonia was not quite dry, and in consequence the color of the powder was light, showing the presence of but little nitride; on fusion with caustic potash but little ammonia was given off.

Lastly, pulverulent zirconium was heated to a bright redness in a tube of Bohemian glass, through which passed a stream of dry cyanogen. The glow alluded to above appeared and spread over the mass. On cooling, an amorphous powder was obtained, of black color with a shade of chocolate-brown; this, after gentle heating in the air, was fused with caustic potash and gave off ammonia in large quantity. Strongly heated in the air, the powder took fire, and burned nearly white; after burning, it gave with caustic potash slight but distinct traces of ammonia. The black powder was not dissolved by muriatic acid, and appeared to be scarcely affected by the nitro-muriatic acid. Hot oil of vitriol seemed to act on it but slightly and very slowly; the acid became brown, and a little gas, apparently sulphurous acid, was given off; hence it is probable that this powder contained carbon—was perhaps a nitro-cyanid.

These experiments would seem to show that—

(1.) Zirconium, like titanium, silicon, and boron, has a strong affinity for nitrogen, is capable of removing it from some of its compounds, and will even unite directly with it when free and inert, as in atmospheric air.

(2.) The relation, thus indicated, of zirconium to titanium and silicon, supports the evidence afforded by the late experiments

of Deville and Troost on the vapor-density of chlorid of zirconium, which appears to have the formula $ZrCl_2$, analogous to $TiCl_2$ and $SiCl_2$.

(3.) Zirconium has probably not quite as strong an affinity for nitrogen as some of the other elements named above. As prepared from ammonia or cyanogen at least, its nitride burns when strongly heated in the air, like the nitride of niobium of H. Rose,* and perhaps the nitrides of tungsten and molybdenum;† in contact with water nitride of zirconium is probably subject to slow decomposition, like nitride of silicon.‡

(4.) It would be desirable to examine the action of chlorine upon this nitride of zirconium at a high temperature, so as to ascertain whether cyanogen may exist in any of the specimens prepared by different methods; also to endeavor to obtain the compound in crystals of larger size, and to get a qualitative analysis of it in a state of purity.

ART. XXXVII.—*On the Atomic Weight of Lithium;* by J. W. MALLET, Prof. Chemistry in the University of Alabama.

(Read before the Amer. Assoc. for the Advan. of Science, Aug. 1859.)

IN a paper read before the American Association for the Advancement of Science in August, 1856, I endeavored to show that the equivalent of lithium, which has been usually taken, on the authority of Berzelius, as 6·5 (=81·25 on the oxygen scale), or 6·6 (=82·50), is in fact considerably higher, and may be assumed =7· (or 87·50).

The error involved in the older determinations was noticed as due to the fact, observed by Marignac and others, that when a sulphate (the salt analyzed) is precipitated by an excess of chlorid of barium, traces of the latter are thrown down with the precipitate and cannot be removed by washing, thus bringing out the quantity of sulphuric acid greater, and the atomic weight of the base less than the truth.

My own results were obtained by the method used by Pelouze in determining the equivalents of sodium and barium, namely, the precipitation of chlorid of lithium by a solution of silver of known strength. In this way the equivalent of lithium was found by three experiments =86·93, 86·96, 86·45, or in the mean 86·78 (or 6·95 as referred to the hydrogen unit).

Since the publication of the above result, it has been confirmed by Dumas, who, in one of his recent papers on the equivalents of the elements, states that he has found that of lithium

* Ann. d. Chem. u. Pharm., Mai, 1856, S. 140.
† Ibid., Feb. 1858, S. 259.
‡ Ibid., Mai, 1859, S. 249

=7·, without however giving the details of the experiments on which this number is based.

On the other hand, Troost, in a paper upon the general history of lithia and its salts,* has objected to the method by which my determination of the equivalent was made, and has returned to a number near that originally given by Berzelius. Troost states that chlorid of lithium on being heated in the air loses chlorine and takes up oxygen, so that it must give by the method of Pelouze an atomic weight for the metal higher than the truth. This fact was distinctly noticed in my former paper, and it was stated that the decomposition might be prevented by addition of a little pure sal-ammoniac to the chlorid of lithium before heating. Troost objects to this, not that he has proved the method of correction defective, but that we cannot in the end tell whether the salt contains its full proportion of chlorine or not, unless the true equivalent of lithium—the constant we are in search of—be known. But it is to be remarked that the product of the exchange of chlorine for oxygen is caustic lithia, exhibiting a strong alkaline reaction. I have twice or thrice prepared chlorid of lithium, adding sal-ammoniac, and igniting in a well closed platinum crucible, and have always found that several grams dissolved in a very small quantity of water (the salt is extremely soluble) gave not the slightest alkaline or acid reaction with the most delicate vegetable colors.

Troost himself adopts crystallized carbonate of lithia as the salt to be analyzed in order to determine the equivalent. He precipitates the carbonate, washes it thoroughly, diffuses it in water through which carbonic acid gas is passed until the salt dissolves, evaporates the solution until the carbonate is deposited as a crystalline powder, and dries this powder at 200°. He determines the lithia in one portion of the salt by evaporation with pure sulphuric acid, and the carbonic acid in another portion by noting the loss of weight on fusion with silicic acid. In this way he arrives at the number 6·6 (=82·5). No proof is offered that exposure to a temperature of 200° is capable of removing every trace of water and all carbonic acid over a single equivalent; yet, unless this be effected, the atomic weight of lithium will be brought out less than the truth. The same result will follow from the mechanical loss of the least drop of fluid during the effervescence of the carbonate with sulphuric acid or the subsequent evaporation of the sulphate of lithia; and, without feeling the slightest doubt of the manipulative skill of the French chemist, we must admit that, in so delicate a process as the determination of an atomic weight, the solution of a carbonate and evaporation of the solution—steps which are generally

*Ann. de Chim. et de Phys., [3], t. LI, p. 108.

looked upon as undesirable in the common course of analysis—should, if possible, be avoided.

I have recently made a new determination of the equivalent, deriving it now, from experiments upon the sulphate of lithia; applying, however, a method avoiding as I hope the source of error to which Marignac has drawn attention; an error which threw much difficulty in the way of his successful estimation of the atomic weights of cerium, lanthanum, and didymium. If we add a salt of baryta in excess to a solution of any sulphate, the precipitate usually contains a small amount of the soluble barytic salt, which cannot be washed out, and which therefore increases the apparent amount of sulphuric acid present, if the latter be calculated from the weight of the sulphate of baryta, supposed pure. On the other hand, if the soluble sulphate be in excess, it will mix with the precipitate to some extent, and thus the proportion of sulphuric acid may be brought out higher or lower than the truth, as the equivalent of the base under examination is lower or higher than that of baryta. So that, if we wish to determine the atomic weight of lithium, as Berzelius did, by mixing the solution of a known amount of sulphate of lithia with chlorid of barium and weighing the sulphate of baryta precipitated, we are not certain that the weight of the latter really corresponds to the quantity of sulphuric acid in the salt analyzed. The same objection applies to Marignac's analysis of the sulphates of cerium and the allied metals. He there noted the volume of a solution of chlorid of barium of known strength required to precipitate a weighed portion of the sulphate; when a precipitate ceases to form, more or less chlorid of barium may have been used than is really equivalent to the sulphuric acid present.

The amount of the above error, must however be constant if the sulphate precipitated, the salt of baryta used, and the circumstances of precipitation be all the same. If the same salt of baryta be used to precipitate *different* sulphates, it is probable that the amount of error will be different for each. But, if we take the sulphates of two very similar and closely related bases, it is probable that *the difference* in the amount of error will be very small. These considerations have led to the following method for determining the equivalent of lithium.

Sulphate of lithia was prepared, with all possible care, from the carbonate, and tested rigidly as to its purity. Two separate portions (A, 1, and 2,) of this salt were rendered anhydrous by cautious application of a heat below redness, and accurately weighed. Two similar portions of perfectly pure sulphate of *soda* (B, 1, and 2,) were dried and weighed with equal care. And, lastly, two portions of pure sulphate of *magnesia* (C, 1, and 2,) were in like manner dried and weighed. Soda and magnesia

were chosen for comparison with lithia because the last-named base seems in most of its relations to hold an intermediate place between the former two, with which it is closely allied. Chlorid of barium was also prepared with all the precautions needed to ensure its purity, precipitated twice from its aqueous solution by alcohol, and recrystallized three or four times. It was at last obtained as a fine crystalline powder by stirring the hot saturated solution as it cooled, and this powder was allowed to dry spontaneously in the air at a temperature of about 80° F. Thus prepared, the salt—as Marignac has shown—is not altered in weight by further exposure to air, its theoretical composition is BaCl+2HO, the precise amount of water actually present was probably a little greater, owing to the mode of drying, but was unimportant under the conditions of experiment adopted.

For each of the six weighed portions of sulphates mentioned above, the quantity of chlorid of barium needed for exact precipitation was calculated, assuming the equivalent of sodium =23, that of magnesium =12, that of lithium =7, and that of barium =68·6, and considering the chlorid of barium as containing strictly two atoms of water. Six portions of the last-named salt were weighed out (at the same time), each less than the amount calculated by one or two centigrams. Each was dissolved in 200 cubic centimetres of hot water, and added to its corresponding portion of sulphate, likewise dissolved in 200 cub. centim. of hot water. The fluid and precipitate in the six beakers were well stirred, and left to settle.

A solution was now prepared of 1 gram of the crystallized chlorid of barium (weighed out at the same time with the larger portions) in 1 litre of water, each cubic centimeter corresponding therefore to 1 miligram of BaCl+2HO. With this standard solution, dropped from a pipette whose degrees $=\frac{1}{5}$th of a cubic centim., the precipitation of the fluid in each of the six beakers was completed—the amount of chlorid of barium thus employed was noted, and added to the weight of the main portion originally taken. At first it was easy to observe the formation of a precipitate on each successive addition of the chlorid of barium solution, and subsidence took place quickly; but, as the point of exact neutralization was more and more nearly approached, each observation became more difficult, and hours and even days were required in order to observe the production of a cloud by each drop added, or to get the fluid clear again for another trial. When the last addition of chlorid of barium altogether failed to produce a precipitate, a single drop of a solution of sulphate of soda was added, and the formation of a cloud noticed.

In this way the following results were obtained:—

A, 1.—3·8924 grm. of LiO, SO_3 required for complete precipitation 8·6323 grm. of BaCl+2HO as used.

A, 2.—4·6440 grm. of LiO, SO_3 required 10·2940 grm. of BaCl+2HO.

B, 1.—5·0675 grm. of NaO, SO_3 required 8·6920 grm. of BaCl+2HO.

B, 2.—5·1107 grm. of NaO, SO_3 required 8·7688 grm. of BaCl+2HO.

C, 1.—4·3380 grm. of MgO, SO_3 required 8·8318 grm. of BaCl+2HO.

C, 2.—4·6625 grm. of MgO, SO_3 required 9·4872 grm. of BaCl+2HO.

Calculating now from B, and C, the amount of crystalline chlorid of barium necessary to precipitate *an equivalent* of NaO, SO_3 or MgO, SO_3, we get the following numbers, which represent what may be called *the practical equivalent* of the chlorid of barium as actually used.

		Means.	
From B, 1.	121·78	121·80	121·96
" " 2.	121·82		
" C, 1.	122·15	122·12	
" " 2.	122·09		

the theoretical equivalent of BaCl+2HO being 122·1—the presence of any water over the normal two atoms tends to raise the practical equivalent—the presence of any BaCl in the precipitated BaO, SO_3 has the same effect,—the presence of either of the soluble sulphates in the same precipitate leads to an opposite result. From this practical equivalent of chlorid of barium and the results given above under A, 1, and A, 2, we may calculate the equivalent of lithium. If we adopt for chlorid of barium the number 121·80—that obtained by the precipitation of NaO, SO_3—we have for A, 1,

$$\frac{3{\cdot}8924+121{\cdot}80}{8{\cdot}6323}=54{\cdot}92=\mathrm{LiO,\ SO^3}$$

$$54{\cdot}92-48(SO_3+O)=6{\cdot}92=\mathrm{Li}$$

and for A, 2,

$$\frac{4{\cdot}6440+121{\cdot}80}{10{\cdot}2940}=54{\cdot}95=\mathrm{LiO,\ SO_3}$$

$$54{\cdot}95-48=6{\cdot}95=\mathrm{Li}.$$

The mean of the two results is 6·935.

If we take for chlorid of barium the number 122·12—derived from the experiments with MgO, SO_3—we get by a similar calculation,

From A, 1, - - - - - Li=7·07.
" " 2, - - - - - Li=7·09.

or, in the mean, 7·08.

Lastly, if we take the mean of the two numbers for chlorid of barium, namely, 121·96, we get for

A, 1, - - - - - - - Li=6·99
" 2, - - - - - - - Li=7·02

or, in the mean, 7·005.

Hence, we find, that the equivalent of lithium, as deduced from the mean results of the above experiments, comes out

6·935 (=86·69 on the oxygen scale)
7·080 (=88·49 " " " "
7·005 (=87·56 " " " "

or as we take the *practical equivalent*, or actual precipitating power, of chlorid of barium from the experiments with NaO, SO_3, those with MgO, SO_3, or the mean of the two, these numbers exhibiting close agreement, and obviously indicate 7· as the true equivalent of the metal. It will be observed that the above method is independent of a knowledge of the exact equivalent of barium, and uses chlorid of barium merely as a means of bringing sulphate of lithia into comparison with the sulphates of soda and magnesia—the equivalents of the two last named bases may be considered as ranking among those best established —and the small difference between *the practical equivalents* for chlorid of barium deduced from these two shows the probable extent of error involved in the assumption of the same constant in the precipitate of the sulphate of lithia.

While these results confirm those formerly obtained by the analysis of chlorid of lithium, I do not consider them of superior or perhaps even of equal value. The estimation of chlorine by the method of Pelouze is apparently one of the most simple and exact processes for the determination of an atomic weight which have ever been proposed, and it is, as I believe, fully applicable to the case of chlorid of lithium.

As the result of both sets of experiments we may fairly take the number 7· (=87·50) as representing the true equivalent of the metal.

ART. XXXVIII.—*Notes on certain Ancient and Present Changes along the Coast of South Carolina*; by OSCAR M. LIEBER, State Geologist, S. C.

IT is very evident that remarkable changes have taken place on the coast of South Carolina during the present geological epoch; changes, which have effected or are yet, effecting very conspicuous alterations in the contour of the coast as well as in the hydrography of the immediate interior, and the elevation

and character of the land. Five or six prominent effects of change I think may thus be distinguished:

I. An ancient depression along our coast.

II. A total change in the course of the portions of the rivers near the coast.

III. A more recent superficial elevation of the coast and—

IV. Consequent gradual seaward extension of the coast.

V. A present depression of the coast and

VI. A southward translocation of our littoral islands.

Of the ancient depression of the coast we find an indubitable proof in the piles of oyster shells accompanied by charred wood and Indian pottery, found in ditching the rice fields sometimes at a depth of five or six feet, and near the level of low tide at a distance of thirty miles frequently from the mouth of the river, (as at Mr. Langdon Cheves' plantation opposite Savannah). This fact also seems to indicate that the coast must, at the time that these oyster piles were formed, have been far nearer, for the distance from the sea would be too great to render transportation likely. It also shows the gradual rise of the land by surface accumulation, of which, of course, there are many other indications in the fertile alluvium of the rice-lands.

The formation of some of these rice-lands is itself connected with a remarkable change in the general character of the seaboard. Let us take Cooper river for instance, as that affords one of the most remarkable cases in the State. Any map of moderate accuracy will show that the length of this river bears no proportion to its width. At the same time it is accompanied on either side by wide bodies of alluvial accumulations, which could not possibly have had their origin in material derived from the adjacent country, which, with the solitary exception of an occasional bluff of eocene marl, (as at Mepkin), is a region of pure and coarse sand, whose effects, wherever it is washed into the rice-lands, is materially injurious.

The rice-lands themselves are composed of a rich tough loamy soil having at times a thickness of sixty feet (*d* in Fig. 2, B in fig. 1), containing no visible organic remains—not even infusoriæ, as Dr. E. Ravenel informs me—but perfectly homogeneous in its composition. Upon this substance rests a stratum composed either of the remains of marsh grass or of drift-wood and bay-roots, &c., according as the surface is more or less exposed to the tidal inundations of salt water. This stratum is observed at C C in fig. 1. In those places where it is regularly covered by salt water, the accumulations of the whitened shells of dead mollusca are often visible even at a distance. C C is evidently a far newer formation than B and altogether distinct in its origin. There are cases, for instance close to Dr. E. Rav-

enel's residence, where the stratum, C C, may be observed to extend into the adjacent sand bank, while at another point on

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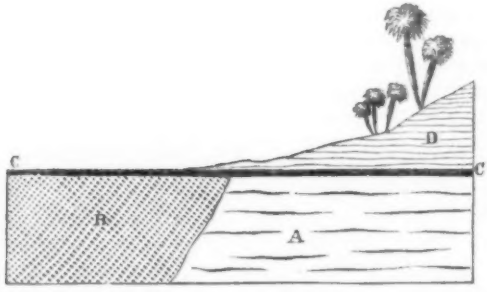

the same plantation the drift wood contained in this bed, was struck at a considerable distance from the edge of the bank. D, therefore, assumes the appearance of a drift-sand. A, may either represent earlier sand strata (probably post-pliocene, but containing no fossils), clearly marked, highly fossiliferous post-pliocene clays and marls, or the more durable eocene marl beds.

In some places the bed, C C, presents an extremely light, semi-peaty mass of greatly increased thickness (as on Savannah river: Mr. Cheve's plantation, &c.), when dry it ignites with the greatest ease, leaving scarcely any ash. Of this feature advantage has been taken to reduce it to the level of the rice-fields now in cultivation, where its natural elevation and more inland position raises it above the tidal irrigation, it is then annually burnt off. For one year it will then yield a good corn crop, by repeating the operation its level is gradually reduced, and the land which it covers rendered available to rice-culture. (L. C's plantation.)

We have seen that the stratum, C C, often underlays the adjoining sand hills, while the far more massive bed, B, terminates abruptly on striking either the marl-bluffs or the solid sand-banks. C C, is therefore not the more recently accumulated part of B; but entirely independent.

With rivers like the Savannah, the Santee and the Pedee we find the source of the mass B at once explained by the presence of those water-courses. But with rivers like the Combahee, Ashepoo, and especially the Ashley, Cooper and Wandoh, no such existing source is visible. The present streams do not extend sufficiently far into the interior, nor do they drain sufficiently fertile regions to have been able to accumulate so very rich a deposit; yet they are the very ones, where this stratum is observable in its greatest development. If we notice the great ramifications of the swamps of this region, the solution, how-

ever, becomes apparent, and we are then taught that these rivers did at one time drain large portions of the back country, the Santee having probably at one time debouched into the Atlantic near Charleston. Subsequent driftings of the sands of the region have in part obliterated the boundaries of the connecting swamps, but over the greater distance we may yet trace them with considerable facility. The homogeneous unstratified character of the deposit, B, and the marked absence of drift-wood, appears to me to render it likely that it was the result of a gradual but constant sub-aqueous deposition of sand, and that such freshets did not occur in those days, which now transport trees and logs from the interior. We have ample and historical proof indeed that these fluvial inundations have greatly increased since the clearing and cultivation of the "Up-Country."

Where the bodies of land, to which we have just devoted our attention, are situated near the sea-coast, the horizontality of their surface affords us an exceedingly reliable guage, by which to determine the changes in elevation which take place on our sea-board.

In fig. 2 I have given an ideal section, which might represent a section across Cooper river. In this figure, *a b*, represents the

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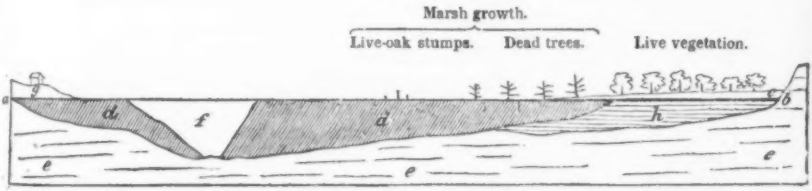

medium level of the water, the level at half tide, *c* and *g*, are beds of sand (the sand hills at *g*,) which have in part drifted over the alluvial deposits represented by *d*. It is probable that on both sides of the river *f*, I have extended the sand *c g*, too far over the mass *d*, or rather have extended the latter too far beneath the former, for I have enjoyed no opportunities of studying the extreme lateral extent of *d*, *beneath* the sand, or the joint boundary of the older sand bed *h*, and of the marl beds *e*, beneath *d*. Undoubtedly the case presented in fig. 1 is the most common, and the eocene beds which appear in high bluffs on the east and show themselves in the bed of Cooper River, may therefore lie much nearer the surface on the west side, than I have here represented. This has however little to do with the question which we now approach.

It has been said that a gradual depression and submersion is manifest on our coast. This I have endeavored to exhibit in

fig. 2. Passing along from the river, we first observe a strip of marsh, containing no remains of a forest growth, next we come to a portion already entirely covered by the high tide, where the stumps of the most enduring trees—the live oak—may yet be seen. After this we enter another portion where the marsh growth is not universal, and in which pine and other trees, dead in part, though still standing, may be found. The soil is sandy. Leaving this we pass through a strip of dying forest into that which is still living, but upon which the salt water is gradually but surely encroaching. In all its varied stages we thus perceive the effects of this depression. The salt water gradually moistening the soil around the roots of the trees, they speedily sicken and die, and before the depression has sufficiently advanced to allow the tides to cover the surface and develop a complete saline vegetation, most of the trees have fallen and decayed, a few isolated stumps of live oaks alone remaining to mark the presence of the ancient forest. Dr. Ravenel had the kindness to show me some points on his plantation where this fact is exhibited in the highest degree of perfection.

To what then can this submersion be due? Mr. Tuomey in his "Geological Report on South Carolina" explains it as resulting from land-slides. He regarded it as produced by the washing away of underlying quick-sands, numerous local instances of which are indeed presented. Thus at Cainhoy, the famous post-pliocene locality on Wandoh river, we observe such slides, where the water has gradually undermined the sand banks. The trees in consequence, assume vertical or slanting positions, in accordance with the circumstance of the action of the water and the extent to which their roots afford them support. But I am induced to believe that such action must be purely local. The far more conspicuous phenomenon to which I refer, can scarcely be satisfactorily explained in a like manner. The single slides rarely extend inland beyond twenty-five feet, while the submersion referred to, is often clearly observable for a distance of at least a mile. Moreover the slides or land-slips are sudden and accompanied by true faults, which are in no instance observable in the other case, nor could the washing away take place except with abrupt banks.

A better explanation, it seems to me, might be sought in a gradual compression (a *settling*) of the deposit *d*, though even that appears to me too local, apart from the fact, that such settling is not likely to exist with a bed, which is constantly exposed to the same, or even to an increased quantity of moisture, and which has already for such an unknown time enjoyed all the facilities for compression, without any present increase of weight above it, from which we might deduce an accelerated action of the kind. To me a positive submersion of the coast,

dependent upon far more vital changes of the crust of our globe, —such as have already been observed in other regions of the world—appears to offer a much more satisfactory explanation. No other suggestion it seems to me can explain the growing inroads of salt water; where neither steep bluff-banks, underlying sand beds or alluvial deposits exist. In addition to this we have already in an earlier part of this communication believed ourselves enabled to detect ancient effects of a similar kind and in so far, at all events, we are supported by analogy when we assert, that a sure and positive though very gradual submersion of our coast is now in progress, at a future day perhaps to be replaced by a gradual elevation.

Another change in the contour of our coast is observable, though confined in its effects. I allude to the gradual southward translocation of our sea-board islands. The northern extremities are constantly washing away and the southern beach extending with equal regularity. This is very beautifully marked with some of the Hunting Islands near Beaufort. Thus Col. B. J. Johnson pointed out to me the spot where he had shot his first buck, which is now a hundred yards or more out in the Atlantic. This change is no doubt due to littoral counter-currents in the Gulf Stream.

Camp Geol. Survey, S. C., August 7, 1859.

ART. XXXIX.—*On the Sudden Disappearance of the Ice of our Northern Lakes in the Spring;* by Gen. J. G. TOTTEN, Chief Engineer, U. S.

(Read before the American Association for the Advancement of Science, held at Springfield, August, 1859.)

SOME forty years ago, being at Plattsburgh, N. Y., on the margin of Lake Champlain, and not far from the widest part of the lake, I had a favorable opportunity for studying the phenomenon of the sudden disappearance of the great body of the ice covering that lake, a body of very many square miles in extent, and not less than one foot in thickness.

This striking phenomenon has often given rise to wild speculation and conjecture in the unscientific world. It was the subject of discussion some years ago in this Association, and it is under the impression, perhaps erroneous, that full information was not then and has not been since presented, that I now venture to produce the following substance of my observations, though made chiefly at that distant day.

At the close of a day in April, I think, the whole surface of Lake Champlain, with the exception of a very few "air holes"

or unfrozen portions of at most a few acres each, and a strip of water next the shores, was one great expanse of ice, of a thickness not less than twelve inches, and apparently, looking merely at the surface, as solid as ever.

During the following night there arose a strong wind from the southward, blowing, therefore, nearly lengthwise of the lake; and when I looked out the following morning not a particle of ice was to be seen, but instead thereof, a lively play of water sparkling with "white caps." There was, as determined by immediate and close examination, absolutely no ice upon the water nor in the water; not a fragment, large or small. Upon the lee shore of a bay close at hand, there was however, a fringe of broken ice that had been washed up by the waves; and in the condition of these few remains of the night's work was to be found, it seemed to me, a satisfactory explanation of a change certainly very surprising from its suddenness and completeness, and deemed indeed, even by high authority in philosophy, so much to partake of the marvellous as to require a higher solution than philosophy was able, consistently to supply.

I venture, in offering this mite to the collections of the Association, to give the explanation then suggested by my examinations; because, as intimated before, I am not aware that such particulars as I have to describe, have been connectedly given, although they must have been often exhibited to individual observation, and as often, one would think, have led to a explanation simple, satisfactory and clear within the domain of the consistent philosophy that nature loves.

The fringe of broken ice was found to consist wholly of prismatic fragments, all of which, excepting a few broken transversely, were of uniform length, namely a length exactly equal to the thickness of the mass of ice of which they had been portions.*

The sides of these fragments were irregular as to number and form; the breadth or thickness varying sometimes in the same prism from three-quarters of an inch to an inch and a half—perhaps a little more or less; but notwithstanding such variations, there was a general agreement as to shape and size, and the general result in all was a decidedly prismatic form. There were,

* The following description and remarks, as far as relates to details, belongs to the particular case then—so much to my astonishment and surprise, presented to notice. I have observed since, that the circumstances under which bodies of fresh-water ice are formed, are not always favorable to so clear an exhibition of the law of structure. The vertical arrangement of elongated solid pieces, although sometimes quite irregular as to shape and dimensions, and interrupted, lapping in their length, is however, I believe, always to be seen in blocks of ice in which solution is somewhat advanced, and to be detected by cleavage, unless indeed, the process of congealation has been disturbed by forces too great for an observance of the law of crystallization. Such deviations do not however, it is thought, touch the general conclusions to which our case seems to lead us.

moreover, sometimes to be seen upon their irregular sides, portions of some length that were probably true crystalline faces. Excepting a small portion at one end of each that was evidently made up of half-melted and refrozen snow, they were very transparent, with few air bubbles, and as sonorous, nearly, as similar prisms of glass.

Examinations then and afterwards of floating fresh-water ice, (which alone I have observed,) have shown that the natural effect of the advancing year is gradually to transform ice, solid and apparently homogeneous, into an aggregation of these irregular prismatic crystals, standing in vertical juxtaposition, having few surfaces of contact, but touching rather at points and on edges, and kept in place at last, merely by want of room to fall asunder. Until this change has somewhat advanced, the cohesive strength of ice of considerable thickness is still adequate to sustain the weight and shock of the travel it had borne during the winter, but becoming less and less coherent, by the growing isolation of the prisms, or more and more "rotten," as the phrase is, though retaining nearly all its thickness, the ice will at last scarcely support a small weight, though bearing upon a large surface—the foot of man easily breaking through, and very slight resistance being made to the point of a cane.

Before describing the peculiar preliminary process by which ice is brought to this condition, it may be well to follow out the steps by which the striking phenomenon of the sudden disappearance, by melting, of vast fields of thick ice is accomplished. The final forces of dissolution will vary somewhat with circumstances, but in all cases where the ice has been, so to speak, duly prepared, nothing is wanting to a quick disappearance, but a disruption of the few remaining surfaces of contact in the prismatic assemblage. If this be not abruptly effected by undulations in the field of ice, solution will continue to erode the sides of the constituent prisms, until, being no longer in contact, or adequately sustained laterally, each will drop into the position in the water below, required by the place of its own centre of gravity—that is to say, it will lie upon its side, exposing large surfaces to the action of the warm water. It is easy to see that this will occur, if not simultaneously, with all the prisms, in rapid succession.

But the effects, in the instance that first drew my attention, were the results of violence, causing the greater surprise by suddenly bringing about what, according to the calm process above indicated, would have been postponed for many days.

The condition of the ice on Lake Champlain on the day in April before mentioned, being a mere aggregation of vertical prismatic crystals, cohering only at points and along edges and narrow surfaces, as shown next morning by fragments on the shore, it could oppose little resistance to waves raised by the wind

of the following night. These acting first upon the edges of the air-holes and open spaces between the ice and the shore, caused slight undulations then in the ice itself, and the consequent pulling apart of the feebly cohering prisms, so that, the water surfaces being thereby enlarged, a short time only was necessary for the waves, increasing in altitude and force with the enlarging water surfaces, to send their undulations far before them under the yielding ice. The prisms falling upon their sides, all more or less immersed, affording now large surfaces to the solvent action of water above the melting temperature, and stirred about by the waves, were quickly dissolved. It is not easy to say in how short a time, under such circumstances, the great transformation would be wrought, but there ought to be no surprise that all was accomplished in the eight or ten hours of a spring night.

The preliminary process, before alluded to, of the conversion of masses of solid ice into an aggregation of vertical prisms by partial solution must be dependent on the fact that the law of crystallization in that substance yields prisms with vertical axes. That this is the law is indicated by cleavage as well as by solution; for while this is easy and free in planes perpendicular to the upper surface, it is said, truly I believe, not to be attainable in directions oblique or parallel thereto. Beyond this general fact of a vertical arrangement of prisms it is not necessary to go for elucidation of our subject, even if I could give minute specifications as to the crystallization of ice. I am not aware, indeed, that this question in crystallography, interesting as it might prove, has been very thoroughly investigated; but however that may be, we have demonstrated to us by the natural process of solution, that ice formed as in the case before us, however solid and homogeneous in appearance, contains a hidden array of crystalline prisms. So much is certain; and this, for the present, is enough on that point. May we not farther assume, that in the process of arrangement about the axes of these prisms, as they are projected downwards into the freezing water, the particles of water, in obeying the law of crystallization, crowd out, radially, the portions of air that would otherwise interfere with their just disposition as ice; and that, at last, this air, by accumulation in spaces between the prisms, suffices to prevent further obedience to the symmetrical principle, causing in these spaces, a confused and porous crystallization peculiarly favorable to the action of a solvent? Whether this be the precise cause or not, a condition favorable to dissolution certainly exists in the irregular spaces between the prisms, as we see by the particulars before given.

The process of Daniel for bringing to view the innate crystallization of apparently amorphous masses—namely, submitting

them to the action of a solution of the same substance, so nearly saturated as to exercise solvent power only when the solidification is imperfect—seems to afford a close analogy to that followed by nature, in preparing ice for quick dissolution.

The natural action seems to be this. The early rains of spring throw upon the surface, and by the tributaries, pour under the fields of ice frequent supplies of water, at a temperature melting even at first, and rising with the progress of the year. This warm underlying water, acting chiefly on the porous spaces between the prisms, dissolves them out to the full depth to which the ice is immersed, and perhaps still farther, by capillary action. At the same time, the spongy ice, formed upon the upper surface by melted and refrozen snow, affords warm water, by melting and percolation, to affect similarly the porous spaces between the tops of the prisms.

In this way, during the considerable period intervening between the first spring rains and the final breaking up of the lake, the solid ice is transformed into the condition necessary to a sudden dissolution.

We may assume, indeed, that the solvent action begins on the lower surface, about the time the accretion, by farther freezing, ceases; that it proceeds very slowly, so long as the temperature of the water remains below that of the greatest density, and of course that it goes on more rapidly as the water is lifted above that temperature by the growing warmth of spring.

I regret that I did not take the temperature of the water in the morning after the disappearance of the ice; but on this point I may add to what is said above, that the spring was then well forward, all, or nearly all, the snow had melted from the fields; the early rains and melted snows had for some time been raising the lake, which was then nearly at its greatest height. It was this rise in the lake that had spread a margin of water *that did not freeze* between the great field of ice and the shore. The inference from all the circumstances, that the temperature of the water at the time of disruption, and for some time previous, was not only above the melting point, but also above that of maximum density, seems to me unavoidable.

I may here be permitted to mention another matter connected with fields of lake-ice that has excited some wonder, namely, the movement towards the shore of boulders, sometimes quite large. The process which must have occurred to intelligent observers, and has probably been heretofore explained, seems to be this: after the rising of the water has supplied an unfrozen margin, a strong wind will sometimes cause the whole field to move until its edge meets adequate resistance upon the shore, all boulders encountered in the way, being pushed before it, into an array upon the shore that accurately marks the extent of the

invasion. These lines of boulders are to be seen in many places, registering accurately, not the work of the preceding year, but the greatest effort of any previous year.

The circumstances of some deep-lying boulders may be such that they are rarely embraced, acted on, or moved, and such may long, by fits, continue to be erratic, though finally to join the general shore parade.

The force of these moving fields is very great, even when the decomposing process is much advanced. I have seen a timber wharf, which was about thirty feet square, ten or fourteen feet high, and filled solidly with earth and stones, shoved along the bottom about thirty feet, by a single continuous push of a great field of ice just ready to be resolved into its prismatic elements. The motion was very slow, only to be seen, indeed, by close observation, while the ice was broken at the edge of contact into innumerable fragments, piling themselves, with a tinkling sound, high upon the wharf and following ice.

A simple and effectual guard against this danger to wharf or pier has been found to be, the giving to the exposed face a certain talus (about one of base to two of height, I think), which turns the ice upwards to the top of the structure, where its fragments accumulate, sometimes to a considerable height. This easy diversion of so great a force is due, of course, to the peculiar crystalline structure of the ice, the degree to which it has been decomposed, and the consequent brittleness against a transverse strain. Should there be an unfrozen margin to permit this motion of large fields of ice, before the solution of continuity in the crystalline arrangement, nothing but the solid earth could stand before it.

These remarks have extended further than I intended, and I fear much beyond what was required by the state of knowledge on the subject. But I venture, nevertheless, in reference to the first portion of these remarks, one further observation—namely, that nature seems to have especially provided, in the structure of these wintry coverings of water surfaces, for their prompt removal, when their existence would retard the advancing year.

ART. XL.—*On some Reactions of the Salts of Lime and Magnesia, and on the Formation of Gypsums and Magnesian Rocks;* by T. STERRY HUNT, F.R.S., of the Geol. Survey of Canada. (Continued from this vol., p. 187.)

IV.

Facts in the history of Gypsums, Dolomites, Magnesites and Limestones.

43. The gypsums found in nature may be divided into two classes, those directly deposited from water, and those produced by the alteration of beds of limestone. To the latter division belong the gypsums found in the vicinity of solfataras, where, as Dumas has shown, the slow oxydation of moist sulphuretted hydrogen gives rise to sulphuric acid, which transforms beds of carbonate into hydrated sulphate of lime. We must equally refer to the same class those gypsums which are formed among calcareous rocks by the action of waters containing free sulphuric acid. Such a process I have long since described in Western Canada, where numerous springs containing besides sulphates of lime, magnesia, oxyd of iron, alumina, and sulphuretted hydrogen, three or four thousandths of free sulphuric acid, rise through Upper Silurian strata, in the calcareous portions of which they sometimes give rise to masses of gypsum.

Bischof (*Chem. Geology*, i, 418), who does not appear to have seen my analyses of these acid waters, rejects my view of the epigenic origin of these masses of gypsum, although it will be apparent to every one who examines the facts, that the action of such waters upon calcareous strata must give rise to sulphate of lime. I do not however confound these recently formed masses of sulphate of lime with the older gypsums, which associated with dolomites, sea-salt and sulphur, are abundant in the Saliferous or Onondaga salt group of the same region.—(*Am. Jour. Sci.*, [2], vii, 175; *Report Geol. Survey*, 1848, 150; *Comptes Rendus de l'Acad.*, 1855, xl, 1348.)

These acid waters which make their appearance in an almost undisturbed region, I conceive to have their origin in deeply buried strata, where gypsum or other sulphates may be undergoing decomposition by the action of water and silica at an elevated temperature, a process analogous to that which gives rise to exhalations of carbonic acid gas.

44. Waters containing free sulphuric acid or ferric or aluminous sulphate, may by flowing into basins where carbonate of lime is present, give rise to solutions of sulphate of lime, and the evaporation of these, of sea-water or other gypseous solutions must give rise to deposits of sulphate of lime, which will

belong to the first division mentioned above. These modes of formation however do not account for an important fact in the history of most stratified gypsums, which is that of their almost constant association with carbonate of magnesia generally in the form of magnesian limestone. Beds of dolomite are often interstratified with or include beds or masses of gypsum, while dolomite and carbonate of magnesia are sometimes found imbedded in gypsum or anhydrite. For a description of the magnesite which is disseminated in the gypsum of Salzburg, see Dufrénoy, *Minéralogie*, 2d ed., ii, 424. Small masses of compact and crystalline gypsum, occasionally associated with crystals of calcite and quartz, abound in some of the dolomite beds of the so-called Calciferous sandrock in Canada, and crystallized gypsum and anhydrite, together with sulphates of baryta and strontia, and fluor spar, occur in geodes in the magnesian limestone of Niagara. The anhydrous sulphate of lime not only forms beds by itself but is often met with disseminated in masses, grains or crystals through beds of gypsum, and even interstratified with it, as in the south of France, in the Hartz, Switzerland, and in Nova Scotia, as described by Mr. Dawson. (*Acadian Geology*, 225.) The conversion of beds of anhydrite into gypsum by the absorption of water, and the attendant phenomena, have been described by Charpentier.

45. Both the hydrous and anhydrous sulphate sometimes form the cement of conglomerates or breccias, which enclose flints, fragments of shale and of limestone, as at Pomarance in Tuscany, (Scarabelli, *Bull. Soc. Géol. de France*, [2], xi, 346,) and also at Bex, where the cement of the conglomerate is a granular anhydrite (Charpentier, *Ibid.*, [2], xii, 546).

Gypsums moreover often include clay and sand, and sometimes contain a considerable admixture of carbonate of lime, which in those of Aix, according to Coquand, amounts to eight per cent. The gypsums of Montmartre also contain, according to Delesse, besides some clay and sand, and several hundredths of carbonate of lime, not less than three per cent of soluble silica intermixed. Silica in the form of flint or chert is sometimes found in concretions with gypsum; thus in the miocene clays near Bologna in Italy, flints are met with associated with sulphates of lime, of baryta and strontia, together with pyrites and sulphur. Masses of sulphate of strontia are likewise found in clays with the gypsums of Montmartre, and the association of sulphate of strontia with the sulphur, gypsum and rock salt of Sicily is well known. The gypsums of Madrid, which occur in tertiary clays, are according to Casiano de Prado, accompanied by beds of chert and of magnesite (*Bull. Soc. Géol. de France*, [2], xi, 334).

Besides the rock salt which so often occurs with gypsum, we may here recall its frequent association with the sulphates of soda and magnesia, both of which are found in very many places imbedded in gypsum, or intermingled with rock-salt or with the associated clays. (Bischof, *Chem. Geology*, ii, 421–431.) Large deposits of both of these sulphates occur with gypsum and rock-salt in Spain; in Nova Scotia also sulphate of soda is found in gypsum with boro-calcite, an association worthy of notice from the occurrence of boracite, both crystallized and massive (stassfurthite) with gypsums in Germany.—(How, *Am. Jour. of Science*, [2], xxiv, 230.)

46. The gypsums of the class which we are now describing appear in every geological period. To these apparently belong the masses of gypsum and anhydrite, which at Fahlun are associated with dolomite and serpentine in the chloritic bands of the oldest crystalline rocks of Scandinavia, the probable equivalents of the Laurentian system of North America. On this continent the oldest known gypsums are those already mentioned as occurring near the base of the palæozoic series, and in what is called by the geologists of New York the Calciferous sandrock. As we ascend the series gypsum is occasionally met with in the Clinton and Niagara groups, until we reach the Onondaga salt-group in the Upper Silurian rocks of Canada and New York, which contains great deposits of dolomite and gypsum, occasionally accompanied by sulphur. The gypsums, anhydrites, and brine springs of Nova Scotia belong to the Carboniferous series, while the frequent recurrence of gypsum in Europe through all the higher rocks up to the Miocene inclusive, is too well known to require notice.

47. The so-called primitive gypsums and anhydrites, which in the Alps and Pyrennees occur interstratified with crystalline schists, are now known to belong to altered secondary strata. These gypsums enclose many crystalline minerals, such as talc, mica, epidote, hornblende, dipyre, beryl, quartz, hematite, blende and pyrites. At Saurat in the Pyrennees many of these minerals appear in the vicinity of a mass of granite which penetrates and alters both fossiliferous limestone and gypsum. The latter becomes mingled with and finally passes into limestone. (Coquand, *Bull. Soc. Géol. de France*, [1], xii, 345.) In Algiers, where gypsum is associated with crystalline limestone, gneiss, amphibolite and serpentine, small crystals of beryl are found disseminated alike through the limestone and the gypsum. Some of the gypsums of the Hartz, according to Frapolli, contain nodules of a silicate of magnesia colored by carbonaceous matter, and having the softness and the chemical composition of steatite.—(*Ibid.*, [2], iv, 832.)

48. The marine origin of the greater number of gypsiferous formations is evident both from the accompanying rock salt and the associated fossils, but certain gypsums (as well as certain dolomites,) have evidently been deposited in fresh-water basins. A gypsum from Asia Minor examined by Ehrenberg contains a great number of fresh-water polygastric infusoria, and beds of gypsum occur in the lacustrine basins of Aix and of Auvergne: the gypsiferous strata of the Paris basin are also regarded as of fresh-water origin.

49. Besides the magnesian limestones of gypsiferous strata great deposits of dolomite occur in the rocks of every geological period. I have long since described the dolomites which form extensive beds, often associated with ophiolites and with crystalline limestones, in the Laurentian system in Canada. Great portions of the palæozoic limestones of North America are magnesian, especially in the valley of the Mississippi,* while deposits of dolomites are found in Europe alike in the Permian, Triassic, Jurassic, and Tertiary strata. Mr. Dana has even described as of recent formation a dolomite from the coral island of Matea, examined by Silliman and myself.—(*Am. Journal of Science*, [2], xix, 429.)

50. The mechanical conditions of these magnesian limestones vary greatly; they are sometimes made up of crystalline grains of dolomite, which are strongly coherent, or more rarely form a loose sand. Not unfrequently the magnesian limestones are concretionary in their structure, and may be oolitic or botryoidal. The action of the concreting force has sometimes obliterated the marks of stratification. The porous or cavernous structure of many dolomites is also to be remarked.

* For the following facts with regard to the dolomites of the palæozoic rocks of the Mississippi valley, I am indebted to Prof. James Hall of Albany. We have there in ascending order:

1st. The so-called *Lower Magnesian limestone*, which is regarded as the equivalent of the Calciferous Sandrock, and is from 200 to 250 feet in thickness. It is the lead-bearing rock of Missouri, and probably contains the cobalt ores of that region.

2d. The *Galena limestone*, consisting of about 250 feet of dolomite interposed between the Trenton and the Hudson River groups. It is the lead-bearing rock of Iowa, Wisconsin and Illinois.

3d. The *Niagara limestone*, also dolomitic, about 250 feet in thickness, and sometimes holding galena and blende.

4th. The *Leclaire* or *Galt limestone*, a dolomitic formation interposed between the last and the Onondaga Salt Group. It attains upon the Mississippi a thickness of 500 feet, but thins out to the eastward.

5th. The magnesian limestones of the *Onondaga salt group*, 100 feet thick.

6th. A dolomitic deposit in the upper part of the Carboniferous series.

The formation No. 1, although generally regarded as the equivalent of the Calciferous sandrock, is perhaps the representative of the Chazy limestone, which on Lake Huron is sometimes a pure dolomite, and on the island of Montreal includes thin magnesian beds. The Calciferous sandrock itself, throughout Lower Canada, includes extensive beds of dolomite, and the Hudson River group is characterized by beds of dolomite and of magnesite.

Magnesian limestones often contain large admixtures of clay and sand; dolomite is not unfrequently the cement of breccias or conglomerates, as in the well-known conglomerate of the Permian system in England. Concretionary masses of dolomite sometimes occur in these aggregates, and in the Permian rocks of the Vosges are found in beds of a sandy clay, itself occasionally cemented by dolomite.

I have elsewhere described two remarkable dolomitic conglomerates from the palæozoic rocks of Canada. The first of these belongs to the upper portion of the Hudson River group, and is conspicuously seen at Pointe Levis and on the island of Orleans. The associated rocks are there graptolitic shales, sandstones and fossiliferous limestones, together with great masses of a greenish or grayish-white subtranslucent compact concretionary limestone. This is without distinct marks of stratification, exhibits no trace of organic remains under the microscope, and has all the characters of a travertine or calcareous sinter. Interstratified with this last are beds of bituminous yellow-weathering dolomite, containing carbonate of iron, and always intermixed with more or less sand or clay or both; the clay in one specimen amounted to fifty per cent, while another quartzose variety gave carbonate of lime 53·04, carbonate of magnesia 31·96, carbonate of iron 5·80, silicious sand 8·80=99·60. The latter is a friable crystalline rock, showing in its fracture broad surfaces of cleavage, like the crystals of Fontainebleau sandstone. These dolomites, which contain no fossils, are occasionally traversed by veins of quartz and calcareous spar, or contain small masses of the latter mineral, apparently filling cavities. They are interstratified alike with the travertines and with the fossiliferous limestones, sometimes in large beds, and at other times in lenticular masses or in layers of a few lines in thickness separating masses of the travertine.

The conglomerates of this series inclose in a paste of ferriferous dolomite, grains and rounded fragments of limestone, often having the characters of the associated travertine, together with fragments of quartz and argillite, and small masses of a nearly pure yellowish crystalline dolomite; these are perhaps concretionary in their origin and not imbedded fragments. Other beds of a similar conglomerate occur in the same series having a cement of pure carbonate of lime, and the travertine itself often incloses grains of sand.—(*Geol. Surv. Canada; Report*, 1853–56, p. 465.)

The other conglomerate to be noticed occurs on the islands of Montreal, St. Helens, and several other localities in the neighborhood, and belongs to small detached patches of the Lower Helderberg series, left after denudation, which repose unconformably alike on Lower Silurian and Laurentian rocks. In

some localities they enclose the peculiar feldspars of the latter, in others the fossiliferous limestones, shales, sandstones and cherts of the former series, while in others still the principal elements are black augite, mica and olivine, derived from the igneous rocks which in this vicinity have broken through the Lower Silurian series. These conglomerates, which are remarkable for their great coherence, have a greenish, bluish or grayish yellow-weathering base, and contain much carbonate of iron. The soluble portion of a specimen from St. Helens was equal to 46·0 per cent, and consisted of carbonate of lime 57·8, carbonate of magnesia 16·4, carbonate of iron 25·8=100·0. In one instance these yellow-weathering beds of conglomerate are associated with others of which the cement remains white on the exposed surfaces, effervesces freely with acids, and is pure carbonate of lime. —(*Ibid.*, 1857, 201.)

51. Dolomite also occurs filling up fissures and cavities in other rocks, as in the case of pearl-spar in geodes and veins. The black and yellow marble from northern Italy, known under the name of Portor, and belonging according to Savi, to the Neocomian formation, is composed, by my analysis, of a black, nearly pure limestone containing only one-hundredth of carbonate of magnesia, penetrated by veins of ferriferous dolomite, which gave me 35·5 p. c. of carbonate of magnesia, and 4·6 of insoluble silicious matter, the residue being carbonate of lime and a little carbonate of iron. The veins of magnesian carbonate sometimes give to the Portor the aspect of a breccia.

52. Examples of the apparent infiltration of dolomite occur in black bituminous limestones at Montreal and Ottawa belonging both to the Trenton and Chazy divisions. These limestones, which contain only traces of magnesia, enclose casts of the interior of *Orthoceras, Murchisonia* and *Pleurotomaria*, consisting of a gray crystalline dolomite, weathering reddish, and appearing in high relief upon exposed surfaces of the limestone. In both localities the limestones are traversed by thin irregular veins of a similar dolomite, which communicate with the casts. By the action of dilute hydrochloric acid the limestone matrix is dissolved, and it is seen that the cavity of the fossil is in many cases only partially occupied by dolomite; that portion which is uppermost in the stratum being often filled with carbonate of lime to the extent of one-third or one-fourth, but in other specimens the whole cast is of dolomite. In some of the larger casts there are drusy cavities lined with crystallized dolomite and occasionally containing prisms of quartz. The analysis of a fragment of the cast of an *Orthoceras* from the Trenton limestone at Ottawa, gave me carbonate of lime 56·00, carbonate of magnesia 37·80, carbonate of iron 5·95=99·75. The surrounding limestone, which was compact, bluish-gray, and bituminous, con-

tained 3·9 p. c. of clay and sand; its solution gave 0·6 p. c. of oxyd of iron with alumina, but no magnesia. Similar examples of fossils replaced by dolomite occur in gray limestones associated with the travertines and dolomites of Pointe Levis (§ 50).

53. Magnesian limestones are very frequently destitute of organic remains; in some cases however they may contain calcareous fossils, as in the Niagara limestone at Dudswell, where corals of the genera *Cyathophyllum*, *Porites* and *Favosites*, composed of pure carbonate of lime, and generally bluish-black in color, are imbedded in a yellow ferriferous magnesian limestone which contains an excess of carbonate of lime. This limestone gave by analysis carbonate of lime 56·60, carbonate of magnesia 11·76, carbonate of iron 3·23, insoluble quartz sand 26·72= 98·31. The portion soluble in cold dilute acetic acid was carbonate of lime with four per cent of carbonate of magnesia and a trace of iron, and the residue when digested with dilute hydrochloric acid left 52·0 p. c. of sand and pyrites; the dissolved part consisting of carbonate of lime 51·75, carbonate of magnesia 35·73, carbonate of iron 12·52=100·00.

In the magnesian limestone of Galt in western Canada, which is a pure crystalline dolomite, there are numerous casts of bivalve molluscs, the shells of which were evidently removed by solution after they had been filled and enveloped by the dolomitic matrix, since the walls of the cavities once occupied by the shells of a large bivalve, *Megalomus Canadensis*, retain the markings of the inner and outer surfaces of the shell. Similar moulds of *Ophileta compacta* are abundant in the blue dolomite of Beauharnois, which belongs to the Calciferous sandrock; in a dolomite of the same geological formation from the Mingan islands, the shells of *Ophileta*, *Maclurea* and *Scaphites* are replaced by silica.

In some portions of the Galt formation fragments of encrinal columns are found replaced by dolomite, which is only distinguished by a little difference of color from the matrix. It would appear in this case as if the calcareous fossil having been first removed by solution (§ 30) the cavity had been subsequently filled with dolomite as in the casts found in the Ottawa and Montreal limestones (§ 52).

54. Although dolomites not unfrequently form by themselves masses of great thickness, as in the Jurassic formation of the Tyrol and the palæozoic rocks of the west, they are often interstratified in an intimate manner with pure limestones. Such is the case with the ferriferous dolomites already noticed in describing the dolomitic conglomerates and travertines of Pointe Levis (§ 50). In the Chazy limestone of Montreal, thin irregular layers of reddish ferriferous dolomite, themselves filled with encrinal columns, are interposed between beds of fossiliferous limestone.

The magnesian layers being pulverulent, the encrinal columns, which are pure carbonate of lime, are easily separated from their matrix, which gave me carbonate of lime 40·95, carbonate of magnesia 24·19, carbonate of iron 27·03, silicious sand without alumina 9·01=101·18; the iron was in part as peroxyd. The bluish crystalline limestone distant an inch from the magnesian layer gave 18·4 p. c. of white insoluble residue and 1·09 p. c. of carbonate of magnesia.

In these strata we sometimes meet with similar reddish pulverulent layers which contain no carbonate of magnesia, but are composed of carbonate of lime with a large amount of peroxyd of iron; such a mixture in one instance forms the cement of a breccia of fragments of the blue limestone; it was perhaps at one time a double carbonate of lime and iron.

The thin beds of dolomite above described are closely associated with those holding the dolomitic casts of orthoceratites already noticed; these were enclosed in a nearly black compact limestone, which during its solution in hydrochloric acid evolved traces of sulphuretted hydrogen. The residue contained a little iron pyrites which was removed by nitric acid; it was black from carbonaceous matter, but became white by ignition in the air, and was an impalpable powder, equal to 12·8 p. c. of the rock. Dilute soda ley removed from it 9·5 p. c. of its weight of soluble silica, and the residue had nearly the composition of a feldspar. It gave me, silica 73·02, alumina 18·31, lime 0·93, magnesia 0·87, potash 5·55, soda 0·89=99·57.

The fossiliferous yellow magnesian limestones of Dudswell (§ 53) are in like manner interstratified with beds of gray crystalline limestone containing 6·3 p. c. of sand and only 1·3 p. c. of carbonate of magnesia. These beds having been much disturbed and broken, the interstices appear to have been filled up with portions of the yellow magnesian paste giving rise to a marble which in some portions resembles the so-called Portor, (§ 51).

55. We see from the above examples that dolomites may occur interstratified both with limestones of organic origin and with others which are evidently chemical deposits. Allied to these latter are certain porous tufaceous beds of carbonate of lime which sometimes accompany dolomite. Such tufas occur alternating with the dolomites and gypsiferous marls of the Onondaga salt group. A similar layer of cellular calcareous tufa, free from magnesia, I have observed immediately covering a deposit of crystalline incoherent dolomite in the Eocene series at Pont St. Maxence in France.—(See also Damour, *Bull. Soc. Géol. de France*, [2], xiii, 67.)

56. The chemical constitution of the rocks containing carbonate of magnesia now demands our consideration. Pure dolomite

is well known to consist of equivalents of carbonate of lime and magnesia corresponding to 45·65 parts of the one to 54·35 of the other, and many magnesian limestones have this composition, or contain beside only mechanical impurities, such as sand and clay. Others with an excess of carbonate of lime are shown by the method of Karsten to be mixtures of dolomite with carbonate of lime, which is readily separated by the solvent action of cold dilute acetic acid (§ 28, § 53). The same chemist however found in clefts and fissures of the gypsiferous rocks of Luneberg and elsewhere, carbonates of lime and magnesia mingled with clay, from which dilute acetic or muriatic acid removed the whole of the lime, leaving a residue of from 4·0 to 68·0 p. c. of magnesian carbonate which had evidently been mechanically intermingled with the carbonate of lime. (Bischof, *Lehrbuch*, ii, 1161.) Since the presence of sulphate of lime appears to prevent in a great measure the union of the two carbonates (§ 31), we might suppose that the association of gypsum with these magnesian clays had in some way hindered the formation of the double carbonate. The free carbonate of lime which they contain is however probably epigenic and produced by the decomposition of a portion of the magnesite by the infiltration of dissolved gypsum.

Carbonate of iron often replaces a part of the magnesian carbonate in dolomites, which also sometimes contain carbonate of manganese, and even carbonates of zinc, cobalt and lead. It not unfrequently happens that the sum of the other carbonates in these ferruginous dolomites is more than equivalent to the carbonate of lime. Such is the case with the dolomitic conglomerate of St. Helens (§ 50).

The dolomites of the Hudson River group in eastern Canada are very often associated with copper, nickel, titanium, chrome and manganese. A grayish granular dolomite from Sutton, which contains disseminated chlorite and crystals of magnetite, weathers blackish-brown from the presence of manganese. The foreign minerals are arranged in bands, and layers of the dolomite an inch or two in thickness are apparently free from admixture. The analysis of such a portion gave me, carbonate of lime 40·10, carbonate of magnesia 20·20, carbonate of iron 10·65, carbonate of manganese 7·65, insoluble, chiefly quartz, 21·45= 100·00. The associated crystals of magnetite contained no trace of manganese.*

* Carbonate of manganese is frequently met with in the rocks of this geological series, causing them to weather brownish-black. I have described an impure chloritic limestone of this kind from Granby (Canada East), which contains besides protoxyds of manganese and iron, portions of chrome, nickel and titanium. (Report, 1853-56, 474, and this Journal, [2], xxvi, 238.) Rogers has in like manner noticed the occurrence of a large proportion of protoxyd of manganese in the olive colored slates of the Lower Silurian series in Pennsylvania, and to the decomposition of

57. Magnesian limestones containing an excess of carbonate of magnesia are not uncommon; one from the muschelkalk of Thuringia gave to Senft, carbonate of lime 42·9, carbonate of magnesia 55·4, besides 2·7 of carbonate of iron =101·0. A lacustrine dolomite from the brown-coal formation near Giessen contains, according to Knapp, carbonate of lime 42·80, carbonate of magnesia 49·63, besides oxyd of iron and impurities, and a specimen from the Lower Magnesian limestone from Lake Superior gave to Whitney, carbonate of lime 25·28, and carbonate of magnesia 32·57, besides 37·0 of sand and a little iron and alumina.

Similar magnesian rocks are described by Alberti as occurring in the variegated marls of the *keuper* or upper part of the Triassic system in Germany. A tender greenish schistose marl from Tubingen effervesced very slightly with acids, and gave for 100·00 parts, carbonate of lime 14·56, carbonate of magnesia 19·10, the remainder being clay with a little iron-oxyd. (Senft, *Die Felsarten*, 134.) Von Bibra has described similar magnesian marls from the muschelkalk in Franconia (Bischof, *Lehrbuch*, ii, 1158), and Gueymard from the gypsums of Roquevaire in Provence. The bituminous salt-clays (*salzthon*) which occur with gypsum and rock salt, when freed by washing from soluble salts, contain according to Schafhautl, carbonates of magnesia and iron often with very little carbonate of lime, the argillaceous matter varying from 12·0 to 70·0 p. c. (Bischof, *Lehrbuch*, ii, 1725.) To these clays are perhaps related the magnesian marls examined by Karsten (§ 56). Völckel has described a dark gray rock interstratified with limestone from the *keuper* near Solothurn, and consisting of carbonate of magnesia 54·55, carbonate of iron 33·94, carbonate of lime 0·67, with 10·81 of clay, water, etc. (*L. and K. Jahresbericht*, 1849, 581.)

58. Magnesian rocks allied to the last occur in the Hudson River group of eastern Canada, and were described by me several years since. In the township of Sutton, interstratified with dolomite, steatite and talco-quartzose strata, is a bed of green and white reddish-weathering crystalline rock, gneissoid in structure, and containing variable porportions of magnesian carbon-

such rocks correctly ascribes the origin of the deposits of peroxyd of manganese met with in that region. Beds of silicate of manganese, more or less intermingled with carbonates of manganese and lime, are interstratified with crystalline schists in various localities in New England. I may mention in this connection a compact massive carbonate of manganese which is said to occur in slates supposed to be of Silurian age, at Placentia Bay, Newfoundland, and which I received from Dr. J. W. Dawson. It is conchoidal in fracture, translucent on the edges, with a feeble waxy lustre; color fawn to pale chestnut-brown. H. 4·0. D. 3·25. It is penetrated and incrusted in part with crystalline peroxyd of manganese. Acids in the cold scarcely attack this mineral, but heated nitric acid dissolves it with effervescence, leaving a residue of 14·4 p. c. of silica, of which the greater part is soluble in a dilute alkaline solution. The analysis gave me besides 84·6 p. c. of carbonate of manganese, and traces of lime, iron and magnesia. (Report, 1857, 204.)

ate. A pure and nearly white fragment gave to hydrochloric acid, carbonate of magnesia 83·35, carbonate of iron 9·02, and left insoluble 8·03=100·40; while another specimen from the same mass contained, carbonate of magnesia 33·00, carbonate of iron 19·35, alumina 0·50, insoluble 45·90=98·70. In both cases the solution contained a little nickel, which occurs in the rock, in part at least, in the form of grains of nickeliferous pyrites. The insoluble portion is a silicate of alumina and alkalies, with a little magnesia, and appears to consist of a mixture of feldspar with a little mica and talc, the latter minerals being colored emerald-green by a small portion of oxyd of chrome.

In the township of Bolton there occurs a bed of magnesite many yards in breadth, interstratified between steatite on the one side, and an impure ophiolite passing into diorite, on the other. It is made up of brilliant cleavable grains of magnesian spar, bluish-gray or nearly white in color, and intermingled with others of white hyaline quartz, which sometimes forms small irregular veins. One of several analyses of this rock gave me, carbonate of magnesia 59·13, carbonate of iron 8·32, insoluble 32·20=99·65. In other specimens the proportion of carbonate of iron is a little greater, and traces of carbonate of lime are sometimes met with, while nickel is never wanting and sometimes coats the joints of the rock with a yellowish-green film of what appears to be a hydrocarbonate of nickel; the proportion of this metal determined upon a considerable quantity of the rock was found equal to about one-thousandth. The insoluble residue from this magnesite was greenish-gray in color, and gave by analysis 93·6 p. c. of silica, besides some alumina, 0·8 of alkalies, and traces of lime, magnesia, and oxyd of chrome, which gives an emerald-green color to some portions of the rock. I have already shown that nickel is rarely absent from the magnesian rocks of this region, where it is generally accompanied by chrome. These magnesites in powder do not perceptibly effervesce with cold hydrochloric acid, which however readily dissolves them with the aid of heat. The decomposition of the contained carbonate of iron renders their weathered surfaces reddish-brown and pulverulent.—(*Report*, 1853–56, p. 460.)

I have detected a quartzose magnesite closely resembling that of Bolton, containing nickel, and stained emerald-green by oxyd of chrome, among a collection of rocks brought from California by Mr. W. P. Blake, who also found a bed of nearly pure white compact carbonate of magnesia among the crystalline schists of that region. I may here recall the existence of beds of magnesite among argillites in Styria, and also in the ancient crystalline gneiss of Modum in Norway, where a crystalline magnesite is the gangue of crystals of serpentine and ilmenite.—(*Am. Jour. of Science*, [2], v, 389.)

59. The greater number of dolomites and magnesian rocks are shown by their fossils or by the nature of the associated strata to be of marine origin, but dolomites are also found in fresh-water deposits. Such is that with excess of magnesian carbonate from the brown-coal formation near Giessen (§ 57), and dolomites are said to occur with the lacustrine limestones of Dachingen near Ulm.—(Senft, *Die Felsarten*, 133.)

V.

On the mode of formation of the preceding rocks.

60. Having in the fourth division of this paper brought together the principal facts in the history of magnesian rocks, as well from the researches of others as from our own observations, we have seen that these rocks consist essentially of dolomite, mixed with carbonate of lime on the one hand, and with carbonates of magnesia and iron on the other, passing thus into magnesite. The frequent intermixtures of sand and clay and even of fragments of quartzite, argillite and limestone, clearly show their sedimentary origin, which is moreover rendered evident by the fact that they are often interstratified with pure limestones and even inclose calcareous corals; these facts exclude the idea of the formation of all such dolomites at least, by the alteration of deposits of carbonate of lime as supposed by Von Buch, Haidinger and Favre.

61. The dolomites of the Tyrol which Von Buch imagined to have been formed from the alteration of limestones by magnesian vapors evolved at the time of the ejection of certain melaphyres of that region, have been shown to be much more recent than these melaphyres, which according to Fournet are not intrusive but sedimentary rocks, probably of Carboniferous age, altered *in situ*. These metamorphosed strata are separated from the dolomites, which are Jurassic, by unaltered Triassic strata, including the muschelkalk and a conglomerate holding rolled fragments of the melaphyres.* (*Bull. Soc. Géol. de France*, [2], vi, 506–516.) In several other cases where dolomization was supposed to have been produced by the proximity of igneous rocks, Delesse and Delanouë have shown that the change had been limited to an alteration in the texture, and that there had been no addition of magnesia.

62. Favre supposes with Haidinger that magnesian solutions under heat and pressure have given rise to dolomites by decomposing beds of limestone with formation of carbonate of magnesia agreeably to the observations of Von Morlot and Marignac. (*Ibid.*, [2], vi, 318.) This hypothesis is evidently not applicable

* Bischof cites *Fournet, Histoire de la Dolomie*, 1847, but I have not been able to consult the work in the preparation of this paper.

to those magnesian limestones which include beds, fragments or organic remains of pure carbonate of lime. In any case we must suppose a long continued filtration of solutions of magnesian chlorid through the heated limestone under certain conditions which seem at least improbable.

63. The theory of the formation of magnesian sediments will be readily understood from the experiments which have been described in the earlier parts of this paper, but before proceeding to its consideration I wish to call attention to the results of the concentration by evaporation of natural waters in basins without an outlet. If such a basin contain sea-water, the gypsum, being insoluble in a saturated brine, will be entirely deposited before the crystallization of the sea-salt, and there will remain a liquid containing no lime-salts, but chlorids of sodium and magnesium with a large amount of sulphate of magnesia. Such are the waters of Lake Elton and many of the brine pools of the Russian steppes, while on the contrary the saturated brines of the Dead Sea and some other salt lakes contain little sulphate but abundance of chlorid of calcium, and if they are the residues of sea-water, have been modified by additions of this salt, which has converted the sulphate of magnesia into chlorid of magnesium and gypsum, the calcareous chlorid remaining in excess.

But while some of these saline lakes may be supposed to be basins of sea-water, modified by evaporation, either alone or conjoined with the influx of foreign saline matters, others were evidently once fresh-water lakes in which, the loss of water being equal to the supply, have gradually accumulated the soluble salts of all the rivers and springs flowing into the lake. We may arrive at some notion of the diverse natures of the different saline lakes which would be formed in this way if we suppose the waters of different European rivers to be subjected to evaporation under conditions like those of the salt lakes of Western Asia. In the waters of the Elbe and Thames chlorids greatly predominate (in the latter with gypsum), with small amounts of magnesian salts, and the evaporation of these waters would give rise to lakes containing a large proportion of common salt. In the Seine on the contrary, sulphate of lime predominates, while the waters of the Rhine, the Danube, the Arr and the Arve contain but small amounts of chlorids and large proportions of sulphates of lime and magnesia.

64. In other rivers we find alkaline salts; the Loire at Orleans, according to Deville, contains in 100,000 parts, 13·46 of solid matters, of which 35·0 p. c. is carbonate of lime, 30·0 p. c. silica, while two-thirds of the more soluble salts consist of carbonate of soda. In the waters of the Garonne, with as large a proportion of silica, and more carbonate of lime, the carbonate of soda equals one-fourth of the soluble salts, while 100,000 parts of the

water of the Ottawa, according to my analysis, contain 6·11 parts of solid matters, consisting of carbonate of lime 2·48, carbonate of magnesia 0·69, silica 2·06, sulphates and chlorids of potassium and sodium 0·47, and carbonate of soda 0·41. (*Report Geol. Survey of Canada*, 1853–56, 360, and *Philos. Mag.*, [4], xiii, 239.) Silica, although more abundant in alkaline river waters, which are chiefly derived from crystalline rocks, is not wanting in waters containing neutral earthy salts, like the Seine and the Rhone, of the solid matters of which, according to Deville, it forms respectively 10·0 and 13·0 p. c.—(*Ann. de Chem. et Phys.*, [3], xxiii, 32.)

The waters which rise from the Lower Silurian shales of the St. Lawrence valley are, as I have elsewhere shown, remarkable for the predominance of alkaline salts, which sometimes amount to one-thousandth, or more than one-half the solid matters present; these waters are distinguished from the river waters just mentioned by their comparatively small amount of silica and earthy carbonates, and by the presence of a notable proportion of borates.—(*Rep. Geol. Survey of Canada*, 1852, p. 165,—1853–56, p. 469, and *Proc. Royal Soc., Phil. Mag.*, [4], xvi, 376.)

We may here refer to the strongly alkaline waters furnished by the artesian wells of Paris and London as evidences of the abundance of alkaline carbonates in natural waters, and to the springs of Vichy and Carlsbad, the latter of which, according to the calculations of Gilbert, furnish annually more than thirteen millions of pounds of carbonate of soda. The evaporation of these alkaline waters, whether rivers or springs, must give rise to natron lakes like Lake Van and those of the plains of Araxes, Lower Egypt, and Hungary.—(Bischof, *Lehrbuch*, ii, 1143.)

The carbonate of soda contained in these waters has its source in the decomposition of feldspathic minerals, and shows the continance in our time of a process whose great activity in former geologic ages is attested, as I have elsewhere maintained, by vast accumulations of argillaceous sediments deprived of a large portion of their soda, and also by the carbonate of lime which by the intervention of carbonate of soda has been formed from the chlorid of calcium of the primeval ocean and deposited as limestone.

65. An indispensable condition for the precipitation of carbonate of magnesia is the absence of chlorid of calcium from the solutions, and this in the presence of excess of sulphates is attained simply by evaporating to the point where gypsum becomes insoluble. In nearly all river and spring waters bicarbonate of lime is present in a large proportion, and is often the most abundant salt. We have shown that when mingled with a solution containing sulphate of magnesia, it gives rise by double decomposition to bicarbonate of magnesia and sulphate of lime.

By the evaporation of such a solution, the latter salt, being the less soluble, is first deposited in the form of gypsum, while the magnesian carbonate is only separated after farther evaporation, when, provided the supply of bicarbonate of lime still continues, the two carbonates may fall down in a state of intermixture. In this way sediments will be formed containing the elements of dolomite or magnesite.

66. The solution of magnesian carbonate remaining after the deposition of the gypsum, possesses, as we have seen, the power of decomposing chlorid of calcium, and when deprived of a portion of its carbonic acid by evaporation, reacts in a similar manner with a solution of sulphate of lime (§ 5, § 23). In this way, an influx of sea-water into the basin from which gypsum, and perhaps a portion of magnesian carbonate has already been deposited, would give rise to a precipitate of carbonate of lime, like the tufaceous limestones, whose occurrence with gypsum and dolomites has been already noticed. In basins which, like the salt lagoons of Bessarabia on the shores of the Black Sea, receive occasional additions of sea-water, and deposit every summer large amounts of salt, (Bischof, *Lehrbuch*, ii, 1717,) the influx of waters containing bicarbonate of lime would give rise to the formation of beds of gypsum, alternating with dolomites or magnesian marls and rock salt.

67. We have already referred to the analyses of certain rivers, in which the sulphates are more abundant than the chlorids. Thus, in the Rhine, near Bonn, according to Bischof, we have for 100,000 parts of the water, 17·08 of solid matters, of which 1·23 are sulphate of lime, 1·81 sulphate of magnesia, with only 1·45 of chlorid and 8·37 of carbonate of lime; in the Danube near Vienna, the predominance of sulphates is still more marked. The waters of the Arve, in the month of February, gave to Tingry, for 100,000 parts, 24·5 of solid matters, of which 6·5 were sulphate of lime, 6·2 sulphate of magnesia, and 8·3 carbonate of lime, with only 1·5 of chlorids. Now, as in river waters there is always present an excess of carbonic acid, and as bicarbonate of lime and sulphate of magnesia in solution are mutually decomposed, these waters, which are to be regarded as solutions of sulphate of lime and bicarbonate of magnesia, (§ 18) would, by their evaporation, yield gypsum and magnesian carbonate, which would appear as portions of a fresh-water formation, like those of Aix and Auvergne.

The decomposition of soluble sulphates by bicarbonates of baryta and strontia, will explain the formation of heavy spar and celestine, and their frequent association with gypsiferous rocks.

68. As to the native sulphur which is often associated both with epigenic and sedimentary gypsums, it has doubtless in every case been formed as Breislak long since indicated, by the

decomposition of sulphuretted hydrogen. It is well known that alkaline and earthy sulphates are reduced to sulphurets by organic matters, with the aid of heat, or even at ordinary temperatures, in presence of water. To the decomposition of these sulphurets by water and carbonic acid, we are to ascribe not only the sulphuretted hydrogen of solfataras, which, by its oxydation under different conditions, gives rise either to free sulphur, or to sulphuric acid and to gypsum by epigenesis, but also the sulphuretted hydrogen which appears in springs and in stagnant waters, where the sulphur produced by the decomposition of the gas is often mingled with sedimentary gypsums.* (See Bischof, *Lehrbuch*, ii, 139–185.) This author has suggested the decomposition of chlorid of magnesium by alkaline or earthy sulphurets as a source of sulphuretted hydrogen and hydrate of magnesia, into which sulphuret of magnesium is readily resolved in the presence of water. (*Chem. Geology*, i, 16.) If a salt of calcium were present, this reaction could only take place in the absence of carbonic acid, for carbonate of magnesia is incompatible with chlorid of calcium. The direct reduction and decomposition of sulphate of magnesia by organic matter and carbonic acid may, however, yield sulphuretted hydrogen and carbonate of magnesia, and thus, in certain cases, give rise to magnesian sediments.

69. In the preceding sections, we have supposed the waters mingling with the solution of sulphate of magnesia to contain no other bicarbonate than that of lime, but bicarbonate of soda is often present in large proportion in natural waters, and the addition of this salt to sea-water or other solutions containing chlorids and sulphates of lime and magnesia, will, as we have seen, (§ 1) separate the lime as bicarbonate, and give rise to liquids, which, without being concentrated brines as in the previous case, will contain sulphate of magnesia, but no lime salts. A farther portion of bicarbonate of soda will produce bicarbonate of magnesia, by the evaporation of whose solutions as before, hydrated carbonate of magnesia would be deposited, mingled with the carbonate of lime which accompanies the alkaline salt, and in the case of the waters of alkaline springs, the compounds of iron, manganese, zinc, nickel, lead, copper, arsenic, chrome, and other metals, which springs of this kind still bring to the surface. In this way the metalliferous character of many dolomites is explained, as also the frequent association of metals, such as copper, nickel, cobalt, chrome and titanium, with serpentine, steatite, diallage, olivine, and other magnesian silicates, which owe their origin to the alteration of magnesian sediments such as we have described.

* On certain modes of decomposition of the sulphates, see Jacquemin, *Comptes Rendus*, June 14, 1858.

70. As the separation of magnesian carbonate from saline waters by the action of bicarbonate of soda does not suppose a very great degree of concentration, we may conceive this process to go on in basins where animal life exists, and thus explain the origin of fossiliferous magnesian limestones like those of the Dudswell (§ 53,) and the Silurian rocks of the western United States, whose fossils, as I am informed by Mr. James Hall of Albany, are generally such as indicate a shallow sea. To the intervention of carbonate of soda is I conceive to be referred the origin of all those dolomites which are not accompanied by gypsums, and which make up by far the larger part of the magnesian limestones; nor will the dolomites thus derived be necessarily marine, for the same reagent with waters like those of the Danube and Arve would give rise to dolomites and magnesites in fresh-water formations, which unlike those mentioned in § 67, would not be accompanied by gypsums.

71. To the first stage of the reaction between alkaline bicarbonates and sea water I am disposed to ascribe the formation of certain deposits of carbonate of lime which although included in fossiliferous formations, are unlike most of their associated limestones, not of organic origin, but have the characters of a chemical precipitate of nearly pure carbonate of lime, in which are often imbedded silicified shells and corals.* It is not perhaps easy in all cases to distinguish between such precipitates, which may assume a concretionary structure, (see on this ques-

* The large proportion of dissolved silica which many river waters contain (§ 64) appears in sedimentary deposits, not only replacing fossils and forming concretions and even beds of flint, chert and jasper, but also in a crystalline state, as is seen in the crystallized quartz often associated with these amorphous varieties, and in some beds of sandstone which are made up entirely of small crystals of quartz. Elie de Beaumont long since called attention to the crystalline nature of certain sandstones which as Daubrée has remarked, could not have been derived from the disintegration of any known rock, and Mr. J. Brainard at the meeting of the American Association for the Advancement of Science, held at Cleveland, insisted upon the crystalline character of the grains composing sandstones in Ohio, as evidence that these were chemical deposits. He however fell into the error of supposing that all sandstones and even quartzose conglomerates have had a like origin, while the latter and the greater part of the former are undoubtedly mechanical deposits from the ruins of pre-existing quartzose and granitic rocks.

These crystallized sands according to Daubrée, are met with in beds in the sandstone of the Vosges, the variegated sandstone (Triassic and Permian,) in the tertiary of the Paris basin and elsewhere. Other sands are made up of globules of calcedony, apparently like the crystallized sands a chemical deposit, and associated with oolitic iron ores in the lias, and with glauconite grains in the green-sand. (Daubrée *Recherches sur le Striage des Roches, etc.*, Ann. des Mines 1857, 6 livr.) We may here mention the so-called *gaize* from the green sand of the Ardennes, which gave to Sauvage 56·0 p. c. of amorphous soluble silica mixed with quartz sand and glauconite. (Bischof, *Lehrbuch*, i, 768–811.)

Maschke has shown that under certain conditions silica is soluble in about twenty-five parts of pure water; from this solution it separates by evaporation or by the addition of concentrated saline solutions in a form insoluble in water. (*Jour. für prakt. Chemie*, lxviii, 233.) In these reactions we have a key to the formation of silicious deposits.

tion Bischof, *Chem. Geology*, i. 428,) and those deposits which like travertines have been formed from subterranean springs. In neither case however, should they be confounded with the tufaceous limestones mentioned in § 63.

72. The union of the mingled carbonates of lime and magnesia to form dolomite, is attended with contraction, which in case the sediment was already somewhat consolidated, would give rise to fissures and cavities in the mass. Should the dolomitic strata be afterwards exposed to the action of infiltrating carbonated waters, the excess of carbonate of lime and any calcareous fossils would be removed, (§ 30,) leaving the mass still more porous, with only the moulds of the fossils. Insoluble however as it appears to be at ordinary temperatures, the filling up of such cavities both in magnesian and in pure limestones, not less than its deposition in veins and druses, indicates that dolomite is under certain conditions soluble.

The lowest temperature at which hydrous magnesian sediments may be transformed into magnesite and dolomite has yet to be determined. The requisite heat has however doubtless been attained by the accumulation of overlying sediments, in virtue of that law which causes the temperature to increase as we penetrate the earth's crust. This increase we may suppose with Mr. Hopkins to have been much more rapid in former epochs than at present.—(*Geol. Journal*, viii, 59, also Phillip's *Manual of Geology*, 609.)

Conclusions.

1. The action of solutions of bicarbonate of soda upon sea water separates in the first place the whole of the lime in the form of carbonate, and then gives rise to a solution of bicarbonate of magnesia, which by evaporation deposits hydrous magnesian carbonate.

2. The addition of solutions of bicarbonate of lime to sulphate of soda or sulphate of magnesia gives rise to bicarbonates of these bases, together with sulphate of lime, which latter may be thrown down by alcohol. By the evaporation of a solution containing bicarbonate of magnesia and sulphate of lime, either with or without sea salt, gypsum and hydrous carbonate of magnesia are successively deposited.

3. When the hydrous carbonate of magnesia is heated alone under pressure it is converted into magnesite, but if carbonate of lime be present, a double salt is formed which is dolomite.

4. Solutions of bicarbonate of magnesia decompose chlorid of calcium, and when deprived of their excess of carbonic acid by evaporation, even solutions of gypsum, with separation of carbonate of lime.

5. Dolomites, magnesites and magnesian marls, have had their origin in sediments of magnesian carbonate formed by the evaporation of solutions of bicarbonate of magnesia. These solutions have been produced by the action of bicarbonate of lime upon solutions of sulphate of magnesia, in which case gypsum is a subsidiary product; or by the decomposition of solutions of sulphate or chlorid of magnesium by the waters of rivers or springs containing bicarbonate of soda. The subsequent action of heat upon such magnesian sediments, either alone or mingled with carbonate of lime, has changed them into magnesite or dolomite.

ART. XLI.—*On Gallic and Gallhumic (Metagallic) acid;* by Dr. F. MAHLA, Ph.D., Chicago.

IT is mentioned among the reactions of gallic acid in almost every handbook of chemistry, that its solution produces a deep bluish-black color with a solution of the salts of the sesquioxyd of iron, which disappears, when the solution is heated. As I have nowhere found an explanation of this fact, I have tried to investigate it by some experiments.

When the solutions of the sesquioxyd of iron and gallic acid are used in a diluted state, the resulting mixture appears only slightly colored, but if they are concentrated, it assumes after being heated to ebullition, a dark brown tint, and then causes black spots on the skin, which can be washed away only with the greatest difficulty. Such a solution might perhaps be used advantageously as a hair dye.

If the iron-solution was not added in too large proportion, liquid ammonia no longer precipitates hydrated sesquioxyd of iron, but the proto-sesquioxyd (black oxyd). A reduction takes place therefore, the oxygen transforming some of the carbon of the gallic acid into carbonic acid, which is freely evolved during the ebullition.

To a portion of gallic acid, dissolved in water and heated to ebullition, a solution of sesquichlorid of iron was carefully added in small quantities and the mixture heated again after each addition. This treatment was continued, until a drop of the solution mixed with a little water ceased to give the characteristic bluish-black precipitate of gallic acid with sesquichlorid of iron. A solution of carbonate of soda was then added in slight excess and the black precipitate separated by filtration. A portion of the filtered dark-brown liquor, after being exactly saturated with hydrochloric acid, deposited a voluminous black precipitate, which if dried, formed a black shining mass but when freshly

precipitated, was easily redissolved by free muriatic acid. Such a solution, containing but little free muriatic acid, produced black insoluble precipitates with limewater, with the different salts of lime and baryta, with sulphate of zinc and sulphate of copper. Another portion of the filtered liquor super-saturated with acetic acid, caused precipitates of a black color in solutions of acetate of lead and nitrate of silver. From the silver precipitate, metallic silver was soon separated.

The lead precipitate was carefully washed with distilled water, and after being dried in an air-bath at a temperature not exceeding 200° F. (94° C.) for ten hours, it was heated over a spirit lamp, until the organic matter was perfectly destroyed. The residue, consisting of a mixture of oxyd of lead and metallic lead, was treated with acetic acid, and from it the whole quantity of oxyd of lead was calculated.

1·052 gram. gave 0·662 of the mixture of PbO+Pb, which left after being treated with acetic acid 0·037 metallic lead, a quantity corresponding to 0·041 oxyd of lead. The acetic acid extracted 0·625 oxyd of lead, which quantity added to the above found 0·041 gives 0·666. This is equal to 63·30 per cent.

Gallhumic (metagallic) acid, which was detected by Pelouze in the residue of distillation, when gallic acid was suddenly heated to 480° F. (249° C.) shows the same reactions, and its lead salt, $2PbO, C^{12}H^3O^3$, contains 63·04 per cent of the oxyd of lead. No doubt can therefore exist about the identity of Pelouze's acid and my product. Two equivalents of gallic acid are divided exactly into one equiv. of gallhumic, two equiv. of carbonic acid, and three equiv. of water:

$$C^{14}H^6O^{10} = \begin{cases} C^{12}H^3O^3 \\ C^2 \quad O^4 \\ \quad H^3O^3 \\ \hline C^{14}H^6O^{10} \end{cases}$$

This origin of gallhumic acid forms another and interesting argument, that pyro-acids can be obtained otherwise than by the action of heat.

If some powdered "red precipitate" is added to a solution of gallic acid and heated over a spirit lamp, it is immediately reduced; gallic acid precipitates suboxyd of copper (red oxyd) in a solution of sulphate of copper; this reaction appears with the greatest facility if the solutions are heated together. It also reduces a cold solution of neutral chromate of potassa, producing the green sesquioxyd. The gallic acid is in each of these cases transformed into gallhumic acid. The action of these substances on gallic acid and the formation of the new product, is explained by assuming gallhumic acid to be only an intermediate product, the final result being carbonic acid and water.

ART. XLII.—*The Great Auroral Exhibition of August 28th to September 4th*, 1859.

ON the evening of August 28th, 1859, was commenced an exhibition of Auroral or Polar light which continued with varying intensity at different localities in North America, so far as is now known, up to September 4th. This auroral display is one of the most remarkable ever recorded in the United States; remarkable not only for the great extent of territory over which it was observed, but also for its duration, for the intensity of the illumination as well as the brilliancy of the colors, and the extreme rapidity of the changes. It was also equally remarkable for the magnetic disturbances which accompanied it, especially on the 2d and 3d of September. These electrical perturbations were recorded not only by the usual magnetic instruments, but over the whole system of telegraphic wires, especially in New England and the Canadas, the magnetic induction either greatly interfered with or prevented the working of the lines by the usual voltaic current, while in more than one case the north and south lines were worked during the daytime of September 3d solely by the atmospheric influence! This remarkable and novel phenomenon deserves and will receive special attention hereafter.

It appears from our own correspondence, and from the daily Journals, that the late display of the Aurora was witnessed from Cuba and Jamaica on the south, to an unknown distance beyond the Canadas on the north, and from Central Europe on the east, to California on the west. Doubtless we may expect to hear that it was seen over the entire northern hemisphere, and in some places as far south as lat. 20°.

Since the laws of this phenomenon are as yet but imperfectly understood, it is regarded as very important that the facts respecting the late grand exhibition should be carefully collected and placed on record, in the expectation that at some future day they may afford the basis for a complete and satisfactory theory of this meteor.

We now publish such original observations on this Aurora as have reached us in an authentic form, and we hope in future numbers of this Journal to present many other important data of the same description from different and distant parts of this and the other continent. We intend to present in the first place the *facts* of this exhibition divested of all theoretical considerations; and when all the materials have been collected we shall give such explanation of them as we are able. At present we put on record observations of the aurora and its attendant phenomena made at Lewiston, Me.; at Toronto, Canada West; at New Haven, Conn.; at West Point, N. Y.; at Bloomington,

Ind.; at Springhill, Ala.; at Jefferson Co., Miss.; at Havana, Cuba; and at San Francisco, California. All but one of these having been communicated to this Journal directly from their authors.

1. *Observations made at Lewiston, Maine*, lat. 44° 5′ N., long. 70° 15′ W.; by Prof. ELIAS LOOMIS.

Sunday, the 28th of August, I passed at Lewiston, in the state of Maine. The day was throughout unusually cold and very windy. In the evening, the wind was less violent, but still fresh from the northwest, and so continued until midnight. At 10 P. M. the thermometer stood at 53° F. and the next morning at 5 o'clock it stood at 50° F.

At $8^h\ 20^m$ in the evening I first noticed some remarkable auroral indications. Long brushes of pale white light were shooting up from the west and also from the east, and were directed towards a point considerably south of the zenith; while in the northwest was a large mass of light tinged with a decided rosy hue.

At $8^h\ 35^m$ P. M. the light in the east and northeast had also assumed a rosy tint, while that in the northwest had acquired a deeper red color. At the same time a dark segment rested upon the southern horizon, its vertex having an altitude of about fifteen degrees above the horizon, and its convex edge was bordered throughout by a vivid light which was nearly white but with a decided tinge of emerald-green. In the north was also seen a dark bank similar to that in the south, but less sharply defined, and rising to an altitude of about 30°.

At $8^h\ 45^m$ P. M. in nearly every part of the heavens the light had become more intense, and the streamers were continually varying both in position and in the intensity of their light, presenting the appearance of undulations. From nearly every quarter of the heavens the streamers converged towards one point, but terminated about ten degrees before reaching that point. That point was nearly equidistant from the three stars *Lyra*, *Altair*, and *α Cygni*, but somewhat nearer to Lyra.

At $8^h\ 55^m$ P. M. the elevation of the bank resting on the southern horizon did not exceed five degrees.

At 9 P. M. the light had broken through nearly the entire dark bank in the north, so that there remained only a portion of this bank of very irregular shape, and its average height did not exceed ten degrees. The point of convergence of the streamers was now about equidistant from the three bright stars above named, but inclining a little to the north of that central point.

At $9^h\ 5^m$ the illumination of the southern half of the heavens was much greater than that of the northern; but at $9^h\ 10^m$ the illumination of the southern half had sensibly declined and the

dark bank resting on the southern horizon had risen to a height of 15° or 18°.

At $9^h\ 18^m$ the point of convergence of the streamers was nearly equidistant from the stars above named, but somewhat nearer to α *Cygni*.

At $9^h\ 23^m$ the dark segment in the south was quite regular, and not more than ten degrees in height, and the bright border was very strongly illumined; while the dark segment in the north had almost entirely disappeared, and there was but little light in the northern portion of the heavens, nearer the north horizon than about forty degrees.

At $9^h\ 33^m$ a narrow beam of white light shot up from the west and another similar beam shot up from the east, which met at the magnetic zenith, forming a pretty well defined bow, and being nearly half of a great circle of the sphere. Throughout the entire portion of the heavens north of this arc, there was scarcely any trace of auroral light; while in the south the dark segment was complete, and the diffuse illumination above it was very strong; that is, the usual conditions of the aurora were entirely reversed, and it now appeared wholly on the south side of the zenith, with its base resting on the south horizon.

At $9^h\ 49^m$ P. M. the aurora was entirely confined to a region not rising more than 40° above the southern horizon, and it seemed as if the light was entirely disappearing, passing away towards the south, when very suddenly it increased in brightness, and rose higher in the heavens. Soon it became so bright that I could read with perfect ease the finest printed type. I took from my pocket a paper printed in *nonpareil*, (the finest type often used by printers,) and could read it by the light of the aurora with the same facility as at noonday. The streamers now converged to a point nearly midway between α *Delphini* and α *Cygni*. Soon they covered the entire heavens, reaching down almost to the north horizon. The light in many places, particularly in the south, at an elevation of about 45°, became of a brilliant crimson, and then commenced a succession of flashes like waves of light rolling up towards the magnetic zenith.

At 10 P. M. the point of convergence of the streamers was about equidistant from α *Delphini* and α *Cygni* and about three degrees east of the line joining those two stars. The flashes still continued, but the illumination was less intense.

At $10^h\ 10^m$ P. M. the light had become very pale and diffuse, particularly in the north.

At $10^h\ 14^m$ P. M. almost the entire heavens appeared of that dull slate color which usually characterizes the dark segment near the horizon; but at $10^h\ 19^m$ the whole heavens brightened up again with diffuse brushes of straw-colored light, all inclining towards the magnetic zenith.

At $10^h\ 24^m$ P. M. the point of convergence of the streamers was about equidistant from *α Delphini*, *α Cygni* and *Eta Pegasi*.

At $10^h\ 30^m$ P. M. the corona was very perfect, but the light was chiefly of a straw color, and much paler than it had been about ten o'clock.

At $10^h\ 45^m$ P. M. irregular streamers of pale light covered the entire heavens with the exception of a segment rising about thirty degrees above the southern horizon.

Soon after 11 o'clock I retired, but slept little during the night. The light of the aurora continued until day-light, and made my room nearly as light as a full moon would have done; and I frequently rose to observe the phenomenon from my window, which had a free northern exposure.

At 12 o'clock (midnight) the whole northern half of the heavens was covered with streamers of a diffuse yellow light, and whose borders were not sharply defined.

Aug. 29th at 2 A. M. the whole sky was covered with a haziness, while a number of light clouds of considerable extent were visible, and the whole was lighted up as by a full moon shining through them.

At 5 A. M. the sky seemed unusually clear with the exception of a few light clouds, mostly cirro-stratus, scattered irregularly over the heavens; but near the north horizon was a collection of cirro-stratus clouds forming together a bank rising to an elevation of about eight degrees, and similar to the dark segment observed last evening.

I subsequently ascertained that on the evening of Aug. 28th, snow and sleet were falling upon the summit of Mount Washington (the highest of the White Mountains in New Hampshire), and this snow remained unmelted for several days.

2. *Observations at Toronto, Canada West*, lat. 43° 39′ 35″ N., long. 79° 21′ 30″ W.; by Prof. G. P. KINGSTON, Director of the Magnetic Observatory. (In a letter to the Editors).

Magnetic Observatory, Toronto, Canada, Sept. 24, 1859.

Dear Sirs:—According to the promise conveyed to you in my note of yesterday I send you some facts relating to the Aurora of 28th August and following days. These facts you will notice are not given in a form suitable for publication, but must be considered only as materials for you to work up in the manner best adapted for your purpose.*

* Prof. Kingston's letter was accompanied by a copy of his magnetic records for the two days named—Sept. 2d and 3rd—taken every *fifteen* or every *five* minutes, and for a part of the time every *two* minutes during the hours of observation. These records are extremely interesting and will undoubtedly be presented in full in the records of the Observatory. We have condensed from them the brief table here given.—EDS.

In the magnetical observations the readings of the instruments have been compared with the normal standard readings proper to the time of observation, and the excess or defect from the standard have been then expressed in arc for the declination and dip and in parts of the horizontal and vertical forces respectively for those components of the force. The times of observation are expressed in hours and minutes Göttingen astronomical time. By these means the tabulated numbers are independent of instrumental peculiarities and of local time, and are therefore comparable with results similarly obtained from other quarters. That the deviations given are extraordinarily great will be apparent when it is considered that according to the rule adopted by General Sabine a disturbance is reckoned *large* when the declination differs 5′ the dip 1′ the horizontal force ·0012 and the vertical force ·00026 from their several normal values. Prior to the morning of Sept. 2, the instruments occasionally gave evidence of a disturbed condition of the magnetic elements but not to such an extent as to lead to any systematic reading of them excepting at the regular hours of observation. The Aurora first appeared about 7 : 40 P. M. of Sunday Aug. 28. From which time through the *whole night* the *whole sky* was covered with a brilliant mass of streamers, patches and luminous bands, which rose from all points of the horizon, the predominant color being yellow intermixed with patches of crimson.

At $8^h\ 10^m$ along the *south* horizon was seen a low bank of dark haze similar to that which is common on like occasions in the north horizon, and from which streamers occasionally issued extending towards the zenith and forming with streamers that converged from other points a corona about 16° south of the zenith.

At $8^h\ 25^m$ dense masses of red streamers extended in a band from N.W. to S.S.E., with an intermixture of crimson patches.

On the whole the aurora of Aug. 28 seems to have been characterized not so much by the activity of the phenomena as by the *extent* of the sky which it occupied, (the whole hemisphere,) and by the permanence; for there was little variation in the kind or intensity of the phenomena through the night.

On Aug. 29—Faint auroral light from 8 : 30 in the night, being clear and favorable for observation.

Aug. 30—Sky overcast.

Aug. 31—Clear and unclouded but no aurora recorded.

Sept. 1—Overcast till near midnight. When the sky cleared auroral light was seen accompanied by streamers. At $12^h\ 30^m$ a fine corona was formed round a point 28° S. of the zenith.

Sept. 2—Generally overcast with auroral light occasionally visible through the clouds.

Sept. 3—Aurora visible from sunset consisting of streamers with the formation occasionally of imperfect corona.

Sept. 4—Auroral light with occasional streamers.

Sept. 5—Unclouded, faint auroral light.

Magnetic Disturbance at Toronto, 2nd and 3rd Sept., 1859. *Table giving the variation of the Declination, Inclination, Horizontal and Vertical Forces, from the respective normal values.*

The variations of the declination and inclination are expressed in minutes of arc, and those of the horizontal and vertical forces in parts of the horizontal and vertical forces respectively.

— denotes a westerly deviation or increase of westerly declination and a decrease of dip and of force.

Göttingen time.	Declination.	Inclination.	Horizontal Force.	Vertical Force.	Gottingen time.	Declination.	Inclination.	Horizontal Force.	Vertical Forces.
D. H. M.	° ′	° ′			D. H. M.	° ′	° ′		
2·0·00	9·5	7·7	−·0191	·0028	8·00	14·1	− 2·8	·0024	·0039
·15	41·0	11·1	−·0129	·0039	9·00	11·3	− 2·0	·0016	·0040
·30	52·2	17·4	−·0233	·0033	·30	4·2	− 4·0	·0045	·0047
·34	12·6	16·9	−·0171	·0019	2 10·20	33·3	− 14·4	·0130	·0060
·42	− 40·3	25·0	−·0256	·0012	11·00	11·3	− 9·6	·0095	·0047
·48	16·6	26·1	−·0275	·0019	·10	− 9·7	− 10·8	·0113	·0050
·52	− 40·3	8·6	off scale	−·0027	13·00	6·6	− 1·6	·0044	·0045
1·00	33·1	1 7·3	−·0611	·0001	13 30	43·3	− 18·8	·0268	·0089
·04	− 16·6	46·9	−·0393	·0027	14·00	8·3	3·2	−·0027	·0044
·06	28·7	1 4·9	−·0601	·0036	15·05	− 31·3	13·2	−·0179	·0006
·08	67·6	24·6	−·0672	·0036	·45	22·7	40·0	−·0064	·0021
·10	− 13·7	1 19·6	−·0647	·0027	16·00	− 16·6	16·8	−·0174	·0031
·12	2 6·7	1 20·5	off scale	−·0022	·15	1 4·9	24·8	−·0120	·0006
·20	− 2·9	1 37·3	−·0765	·0025	17·00	− 6·3	3·6	−·0061	−·0014
·26	1 35·0	1 14·5	−·0717	·0056	·45	− 24·0	13·2	−·0015	−·0007
·36	1 41·2	1 42·5	−·0741	−·0013	18·00	− 10·4	9·2	−·0096	·0002
·40	54·4	1 16·9	off scale	−·0003	3 4·00	8·9	5·8	−·0056	·0021
·48	2 6·4	1 0·5	"	−·0031	·10	1·2	4·6	−·0044	·0016
·50	11·2	Off scale	−·0809	Off sc'le	·50	51·1	14·3	−·0146	·0026
·56	27·7	2 29·8	−·0857	−·0057	5·25	18·0	15·6	−·0127	·0034
·04	1 24·2	45·7	−·0566	·0000	·30	40·3	17·2	−·0167	·0033
·06	51·8	51·7	−·0549	−·0006	·40	2·2	18·0	−·0168	·0037
·16	−1 37·2	Off scale	−·0583	−·0021	6·00	− 11·9	15·2	−·0104	·0041
·34	1 26·0	1 16·9	−·0748	−·0005	·15	− 16·3	13·6	−·0081	·0040
·36	49·3	1 25·7	−·0724	−·0032	7·00	− 5·8	2·4	0·00	·0043
·46	2 7·8	1 39·3	−·0630	−·0021	8·00	5·1	0·4	·0022	·0035
·58	57·8	47·7	−·0501	·0006	9·00	− 4·2	7·2	−·0032	·0023
·08	− 29·3	49·3	−·0472	−·0009	10·00	− 14·5	8·4	−·0063	·0023
·24	1 7·2	32·8	−·0406	·0003	3 11·00	1·5	8·0	·0067	·0021
·36	− 10·6	36 8	−·0360	·0000	12·00	6·1	− 0·8	·0028	·0037
·40	− 0·4	29·2	−·0275	·0013	13·00	31·0	− 18·8	·0185	·0037
4·00	32·8	22·8	−·0232	·0038	14 00	5·4	− 0·4	·0006	·0024
·16	8·6	22·0	−·0204	·0031	·05	1·1	1·6	·0011	·0023
·24	22·3	21·6	−·0147	·0035	·35	17·1	− 0·4	−·0014	−·0012
·32	2·5	17·6	−·0154	·0041	·50	− 1·8	4·0	−·0025	·0012
·42	23·8	8·4	−·0128	·0039	15·10	− 4·0	4·4	−·0022	·0025
·52	− 1·4	12·4	−·0109	·0037	·35	29·0	4·4	−·0083	−·0012
5·02	14·8	15·2	−·0147	·0038	·45	− 32·8	7·6	−·0090	−·0012
5·18	− 4·3	10·4	−·0080	·0038	·55	− 16·2	9·6	−·9122	−·0012
5·45	15·1	5·2	−·0069	·0034	16·15	− 5·9	8·0	−·0080	−·0013
6·35	1·7	3·2	−·0043	·0027	·30	− 19·6	7·2	−·0059	−·0012
7·10	9·0	1·2	−·0024	·0040	3 17·00	− 13·2	6·8	−·0064	·0060

3. *Observations at New Haven* (lat. 41° 18′ 27″), by Prof. C. S. Lyman of Yale College.

The Auroral display of Aug. 28th attracted attention at New Haven before the disappearance of daylight; and at $7^h\ 40^m$ mean time, when first seen by the writer, the whole northern quarter of the heavens was covered with a diffused, hazy light, rapidly changing its appearance, often of a crimson or yellowish hue, with occasional streamers, and with a denser mass of light, as usual, above the northern horizon. At $7^h\ 45^m$ this light reached the zenith; at $7^h\ 55^m$ it had passed 25° or 30° further south, and the marginal portion formed for a few minutes, an irregular belt or zone made up of evanescent fragments of arches, intermingled with streaks and patches of auroral light. No distinct bow, however, was at any time formed. At $8^h\ 15^m$ this portion had nearly vanished, and the southern edge was only 3 or 4 degrees below *alpha Lyræ*, then near the meridian. Eight minutes later the edge touched *alpha Aquilæ* and in three minutes more was about 10° south of it. This southern margin was at times quite definite, and as it moved gradually towards the south the following notes were made of it at the time—the altitudes (near the meridian) being measured with a pocket quadrant, and probably in error less than half a degree.

At $8^h\ 27^m$			alt. of edge	28°		
8	29		"	"	20° 30′,	bright and regularly arched.
8	30	30s	"	"	17 15,	bright.
8	31	20	"	"	15 45,	bright, broad, edge well defined.
8	33	15	"	"	14 0,	at star Epsilon Sagittarii.
8	34	30	"	"	14 0,	bright, and well defined.
8	35	30	"	"	12 30,	bright, and very well defined.
8	37	40	"	"	11 20,	edge, well defined.
8	38	30	"	"	10 40,	nearly the minimum alt.
8	40	15	"	"	12 45,	receding, 30′ or 40′ below star ε Sag.
8	42	0	"	"	10 30,	second arch, first 4° or 5° above.
8	47	0	"	"	12 30,	bright, edge well defined—at star ε.
8	49	30	"	"	12 30,	edge at same star.

At this time a small bright horizontal cloud of light some 2° wide and 5° or 6° in length, and pointed at each end, formed rapidly, near the meridian, in the open sky just below the arch at an altitude of 9° 50′, and moved slowly to the west parallel to the arch, through a distance of 15° or 20° till it was lost to view behind trees, about a minute, by estimate, after its formation. This cloud appears to have been identical with one seen by Prof. A. C. Twining at West Point.

The star *epsilon Sagittarii*, referred to above, is found by computation to have had an altitude at $8^h\ 33^m$ of 13° 36′, being then 45^m past the meridian. Its altitude at $8^h\ 50^m$ was 12° 58′. When on the meridian at $7^h\ 48^m$ it was 14° 18′.

At $8^h\ 52^m$, arch at the south growing fainter and breaking up. In a few minutes that quarter of the sky was nearly free from light.

At 8:54 an imperfect corona formed at an altitude of 69°. At 8:56 a better one with bright wisp at its center, alt. 72°. At $8:58\frac{1}{2}$, corona $72\frac{1}{2}°$ apparently in vertical plane cutting *alpha Aquilæ*. (Azimuth of the star then, by calculation, 8° 22′ E.) The corona at these times not very definitely formed.

At $9^h\ 5^m$, a bright mass of light noticed in the east, irregular, expanding, and stretching obliquely upwards and towards the south. At $9^h\ 10^m$ this was met by a similar irregular mass of light stretching around simultaneously from the west, forming an imperfect band or arch, with very little light below it, its lower edge at this time having an altitude of 27° on the meridian. At $9^h\ 12^m$ its altitude was 20° 30′, at $9^h\ 23^m$, 16° 15′, and at $9^h\ 31^m$, 16°, soon after which it faded. While this second curtain was shutting down in the south, it was noticed that the light in the north was rising gradually. At $9^h\ 26^m\ 30^s$ its lower edge passed Polaris, and three minutes later was at an altitude of 62°, leaving the sky below nearly free from auroral light. At the same time, the phenomena overhead began to be more active and brilliant, streamers and cloudy masses of light of various hues, chiefly crimson, forming and vanishing about the corona, attaining a maximum of splendor from 36 to 43 minutes after 9, and at 49^m having become comparatively faint. This magnificent *umbrella-like* canopy, first formed by these tinted streamers and flashes about $9^h\ 33^m$, and then extending not more than 30° or 40° from the corona, with an irregularly scallopped or fringed margin, rapidly expanded in all directions, being more brilliant towards the north, and there presenting the appearance of a descending curtain, or rather succession of curtains, until at $9^h\ 38^m$, it had shut down to the horizon all round, except in the south. The magnificence of the display at this time was not surpassed by anything in the brilliant Auroras of 1837, as remembered by the writer. The curtains just mentioned had at one time something of the drapery-like appearance characterizing the Auroras seen by the French commission at Bossekop in 1838–9.

Although the position of the corona is known to coincide in general with the direction of the dipping needle, its altitude was several times noted with a view to ascertaining its fluctuations, if any. The coronal point, however, was seldom or never sufficiently definite to make the observations of much value for this purpose. In addition to the notes of the coronas before 9 o'clock given above, the following were also made at the time.

At $9^h\ 15^m\ 30^s$ altitude of C. 73°, very definite.
9 18 bright streak or cloud above C. (alt. 76°) lasted $1\frac{1}{2}^m$.

At 9^h 22^m alt. 73°, fine corona, long streamers.
9 24 30^s " 68° 30′, bright wisp near corona. C. not definite.
9 26 30 " 72 15, good corona.
9 28 " 73 15, " "
9 30 40 " 73 0, coronal cloud with rays from it.
9 33 " 73 40, definite, dark center of grand corona.
9 34 30 " 74 30, very fine and definite.
9 36 30 " 75 15, C. not definite, colored streamers, splendid canopy.
9 38 " 72 45, tints brilliant.
9 40 " 74 0, C. definite, bright red, whole display magnificent.
9 41 30 " 74 0, splendid.
9 49 " 73 45, display much less brilliant.
9 52 to 58, brilliant flashes and pulsations, chiefly towards corona.
9 53 10, a shooting star appeared about 15° above Polaris, moving rapidly towards the west over an arc of 15° or 20°.
9 58 Auroral light diffused, faint—colored flashes.
10 0 very little except in north.

Flashes and pulsations continued with varying brilliancy until after 11 o'clock, and according to the testimony of others, the display continued through the night, at times with much splendor.

The mean of the above altitudes of the corona is about 73° 20′. The dip at New Haven is about 73° 50′.

A similar display of rosy streamers and waving light, though less brilliant, was witnessed on the morning of Sept. 2, after midnight, as noticed in one of the morning papers. It was observed about daybreak by Prof. Forrest Shepherd, whose attention was particularly attracted by the rapid flashes and pulsations overhead, which seemed to him to indicate a very low elevation of the phenomena above the earth.

The display was continued on the evening of the same day, being most brilliant between 9 and 10 o'clock when the whole northern heavens to the zenith, and often beyond, was filled with upward flashes and pulsations here and there, chiefly of whitish light, and with but few streamers.

On Sunday evening Sept. 4th, there were indications of a bright Aurora, though a clouded sky prevented it from being particularly observed.

Auroral indications were also noticed on some other evenings of the preceding week.

Unfortunately no magnetic observations were made at New Haven.

The time piece used in noting the phenomena of the 28th was compared the same evening with the astronomical clock of the writer's observatory, and found to be only 5 seconds fast of N. H. mean time.

4. *Observations of Prof.* ALEXANDER C. TWINING *on the Aurora of Aug. 28th*, 1859, *made at West Point, New York.*

While the evening twilight was yet so strong as to make the phenomenon scarcely discernible, a rosy hue was seen spreading over a space reaching from the northeastern horizon to the north star and thence to my zenith, of uniform breadth throughout, and bounded south by a line through Alpha Lyrae, passing vertically down to the east. The time was $7^h\ 25^m$ by the watch—which however varied six minutes from true local time (too fast it is believed, making the local time $7^h\ 19^m$). In about ten minutes the southern boundary moved to Alpha Aquilae, and the rosy light had extended itself visibly over to the west, and streamers were seen in the northeast. Very soon the northern sky became variegated nearly up to the zenith with advancing bands and flakes of yellowish and reddish cloud with streamers intermixed. At a quarter before eight o'clock, by estimation of the true local time, the streamers in the north were numerous; and by careful observation they were perceived universally to move towards the west.

At $8^h\ 35^m$ (by the watch) I looked again. A corona was then formed, and the auroral clouds and streamers were colored with tints of red and yellowish white. The most remarkable phenomenon was exhibited at the southern margin of the illumination. A yellowish cloud of extraordinary density and low altitude was seen advancing southward with an even and massive boundary which stretched entirely across the sky, in striking contrast with the clear blue beneath. It advanced beyond the bright star Antares, but soon receded and took a position which it retained ten or twelve minutes in a nearly level line exactly through that star, and a degree and a half, by estimation, below the star Epsilon Sagittarii. Its altitude therefore during that period—say from $8^h\ 40^m$ to $8^h\ 50^m$ (local time)—was about $11\frac{1}{4}°$, at the first named star, and about $11\frac{3}{4}°$ at the last:—at the meridian it was, probably, 12°. This southern line gave an opportunity for comparative observations in different latitudes, which, if improved, will determine the height of that auroral cloud with an unparalled certainty and accuracy. There was also during this period another phenomenon equally remarkable and, if extensively observed in widely different latitudes, equally valuable. Ten or fifteen minutes before nine o'clock a bright spot formed at or near the meridian, and three or four degrees below the above named level margin. It soon became a long and narrow cloud—say 8° long and $2\frac{1}{2}°$ broad at the middle—but pointed at its eastern and western extremities. It moved to the west in the clear sky, and parallel to the cloudy margin above it. In its course it passed centrally over the pair of

bright contiguous stars in the end of the Scorpion's tail,—showing an altitude, at the cloud's middle line, of 7°. In two minutes—as I estimated from subsequent recollection—it moved about forty degrees. It then was hidden by the mountains in the vicinity. Soon after this disappearance it was observed that the entire expanse of cloud in the south from the zenith down was making a similar progress west,—at about the same rate, as nearly as could be estimated. At $8^h\ 52^m$ (local time) the original mass of vapor had moved nearly out of the southern field—leaving a far less dense and bright accumulation of cloudy strata over all that quarter.

At twenty minutes to a quarter before ten o'clock I observed again. The corona was then finely formed by streamers thickly and completely developed on every side. In about three minutes the display became suddenly very gorgeous, the red and white (yellowish-white) streamers and banks being very brilliant. So they continued for a quarter of an hour at least. In this period pulsations or auroral waves were seen propagating themselves rapidly upwards, and quite to the corona. That these did move upwards was determined by a close scrutiny. The *dome* was completed on every side. The southern streamers were particularly observed to originate beneath in a line or arch which I roughly, and without express verification, judged to be at about the altitude of the cloudy margin as observed at a little before nine o'clock. It may have been somewhat higher. At ten o'clock, or a little earlier, the phenomenon of the narrow cloud moving westward was strikingly repeated. The cloud however in this instance was longer and less definite in shape.

From ten o'clock to $12^h\ 15^m$ I did not observe. At this last mentioned time the auroral twilight shone brilliantly in the north, but my view in that quarter was obstructed.

I observed again from $2^h\ 45^m$ to 3^h. The corona and dome were more regularly and completely formed than previously at ten o'clock, and more than I have seen them in either of the grand auroras of the last thirty years. The streamers were narrow, thick set, evenly distributed, and traceable to the corona. High in the north, observed against the constellation Cassiopeia, they moved across it from west to east, contrariwise to the motion in every instance I have before observed in any aurora. Yet my morning observations on this particular (and nearly or quite universal and yet generally unnoticed) phenomenon of transverse motion have not been so numerous as at evening.* At the spot

* My conjecture as to the occasion of this remarkable feature of auroral phenomena has heretofore been the following:—a *streamer* may be taken as the visible path of some portion of an electric current, normal, or nearly so, to the great thermal current of the earth. Such a normal current, in conformity with known laws, will experience a lateral movement under influence of the thermal current. It will also act upon the latter,—thus affecting magnetic intensity at the earth's surface, and,

observed the motion was estimated as being fully 20° per minute. The ever varying wisps of cloud at the corona, and the southern streamers were also moving to the east. I left the display in full action without observing farther.

The repetition which took place Sept. 3d, although on a vastly diminished scale of grandeur, I observed about one hour,—say from 9^h to 10^h P. M. It was remarkable for the character of the auroral waves, which passed upward, illuminating successively different definite spaces in their path. The motion of these waves was far more moderate than I have ever before remarked. In this instance I could not estimate it to exceed forty-five degrees of arc in a second of time. The movement was everywhere distinctly upward; but the determination of arcual or angular motion in this phenomenon, is excessively difficult and inexact.

5. *Two letters from Prof. Daniel Kirkwood, Bloomington, Ind.*

[*First letter.*]

Aug. 29th, 1859.

TO THE EDITORS, &c.

Gentlemen:—The most extraordinary display of the Aurora Borealis I have ever witnessed was seen from this place last night. It was observed immediately after the close of twilight, and, in the course of an hour, the whole northern horizon from east to west was illuminated. *The phenomenon continued from twilight to twilight;* the brilliancy being greater at 4 o'clock this morning than at any previous hour. It was the lightest moonless night our citizens have ever known. Tints of various colors were seen in different parts of the heavens; but what struck spectators generally with wonder was a thin, gauzy cloud of brilliant red, which appeared first in the east about 9 o'clock in the evening, and which seemed to move almost horizontally till it reached the northwest; at $9^h\ 30^m$ lying precisely over the stars *Alioth*, *Mizar* and *Benetnash*, where it took the form of streamers, converging towards a point somewhat south of the zenith. At the same time an arch of light appeared, having one extremity in the horizon beneath, or rather westward of,

almost of necessity the declination and dip; which seem to be merely resultants of all the electro-dynamic actions upon the needle, subsisting at the time. Under the above hypothesis, therefore, every development of streamers must ordinarily concur with three other phenomena, viz., a lateral movement of the streamers, a change of the needle's direction, and a change of magnetic intensity. The hypothesis of a magnetic property in the auroral medium—whatever the latter be—seems wholly gratuitous. It is only requisite that the medium, or substance through or along which the current passes, shall be susceptible of illumination by such passage. Certain phenomena however indicate that the current transports the auroral vapor laterally with itself. The importance of this class of observations to questions relating to the cause of the aurora, as well as to the direction of currents, is obvious.

these red streamers, the other in the southeast; the zenith distance of its summit being about 40°, and its outer edge just reaching *Arcturus*.

Subsequently a splendid corona was formed, towards which the streamers moved in beautiful undulations. The most remarkable feature in the phenomenon, however, was its *extent;* not only the entire northern part of the visible hemisphere was illuminated, but the greater portion also of the southern.

I have just learned that during the night some lines of the magnetic telegraph were so much disturbed as to stop communication between different points.

[*Second letter.*]

Bloomington, Indiana, Sept. 9th, 1859.

TO THE EDITORS, &c.

Gentlemen:—Since the date of my hasty note of the 29th ult., we have had several more displays of the Aurora. Not having witnessed them myself, however, I have collected from others the following facts in regard to them: the first—a magnificent one—was seen by many of our citizens on the night of September 1st. It was noticed in the north about 11 o'clock, and gradually increased in brilliancy and extent until *the whole visible heavens were illuminated;* the light at times being such that ordinary print could be read without much difficulty. At 1 o'clock in the morning the portion of the heavens in which the light was most intense was almost exactly southeast, about midway between the zenith and horizon. The Stark County (Ill.) News thus describes the phenomenon:—

"On yesterday morning, (Sept. 1st) between one and two o'clock, the whole heavens were aglow with deep red light, which presented every variety of beautiful aspect imaginable. When we first looked out, it looked as if two brilliant suns had just set, one in the east and one in the west, and the sky, at either point was painted in broad streams of crimson and gold. This lasted but a moment, then a deep glow overspread the whole sky, brighter at some points than others, but all red. The light was so strong at times, that we could see to read fine print with ease, and gave to buildings and other objects, a dim glow, like fire-light. An arc of some 20° was formed over the southern horizon, the inside of which presented a silvery appearance like the edge of a cloud brightened by the moon, and from this, broad streams of a lilac color would flash up toward the zenith and abruptly end."

The displays on the nights of the 1st and 2nd, are described by the Indianapolis Journal of the 3rd inst., as follows:—

"*Another Aurora.*—Yesterday morning (Sept. 1) from midnight till day another Aurora, more brilliant than the first, in this locality at least,

was witnessed by those who had the good luck to be up at that time. At half past 11 o'clock it was quite brilliant, as a low arch of pure white light in the north, with but few radiations of colored light, and none that rose very high. It was very luminous, we could see as plainly as by moonlight, when the moon is quarter full, though the light was a paler and more ghastly kind, more like faded daylight than moonlight. Later in the night it grew much brighter still, and extended over the whole visible heavens. A beautiful column of red rays rose in the northeast, and another rose in the northwest, and met in the zenith, and from this point of junction a flood of red light poured out over the sky running down to the horizon on all sides, south as well as north, and the whole earth colored under its beautiful but ghastly crimson. Many who saw it say it was far more brilliant than the one of Sunday night, and it certainly was much more luminous, though less marked by the darting rays and wonderful pulsations that made the first so splendid. It was seen at Cincinnati, and all over the Union, we suppose, as the first one was. Such frequency and splendor of Auroras at this season we never saw or heard of before.

"*Still another.*—Another very beautiful Aurora Borealis was seen last night (Sept. 2) about half past eight o'clock. At that time it was confined to the north entirely. The rays shot up in very distinct cones or peaks of light, and beautifully variegated in color.

On Monday the 5th, about 2 o'clock in the morning, the phenomenon was witnessed for the fourth time within a week. Several beautiful streamers shot up from the northwest towards the zenith. The light, however, was of short duration.

It may be proper to remark that last evening, the 8th, about 9 o'clock, notwithstanding the bright moonlight, indications of the Aurora were again discoverable.

6. *On the Meteorological and Magnetic Phenomena accompanying the Aurora Borealis of Aug.* 28*th*, 1859, *as observed at Springhill* (*near Mobile*), *Alabama;* by Prof. A. CORNETTE, S. J.

I have thought that the meteoric conditions which preceded, accompanied and followed the Aurora Borealis of August 28th would be read with interest by all who witnessed that phenomenon on this memorable occasion. I copy from my daily journal without translating the French metrical numbers which I have for many years employed.

I add some hourly observations upon the perturbations of the magnetic current after the phenomenon, as well also as some observations on the subject at large.*

* In conformity with our design to give at present only facts, we reserve Father Cornette's ingenious speculations to another occasion.

Meteorological Observations at Springhill, lat. 30° 41′ N. *Elevation* 46 *metres.* (In French metrical and thermometrical standards.)

1859	Barometer (uncorrected.)					Attached thermom.		Detached thermom.			Wet bulb thermom.			Absorption.			Temp. wells.
Aug.	4h	9h	12h	3h	9h	Min.	Max	6	2	9	6	2	9	Int'r mm.	Ext'r mm.	wools	
27	760·0	760·9	760·7	759·6	760·0	27°	30°	22°·6	30°·3	24°·4	21·8	23·0	22·7	1·5	6·0	....	
28	59·1	60·7	60·4	59·0	59·0	28	30	22·7	30·7	26·0	21·8	25·0	23·8	1·5	6·0	3·0	21·1
29	59·2	59·9	59·8	57·8	58·2	27	28	24·2	26·4	24·3	22·0	23·0	23·0	1·0	4·0	2·5	
30	758·5	58·6	....	57·2	58·0	27	29	21·2	26·6	22·8	19·2	22·1	20·7	1·2	5·0	....	21·1

	Wind.			Clouds.			Rain.			
	Morning.	Evening.	Night	Morning.	Evening.	Night.	Morning	Evening.	Night.	mm.
Aug.										
27	C $\frac{N}{S}$	N^3 $\frac{N}{S}$	C	S	S	S	0	0	0	0·0
28	C $\frac{N}{S}$	$\frac{N}{S}$	C	S N :	*n*	*n*–S N–	0	0	R^N 0	0·0
29	NW$_3$NW	NW	NW	N :	N–*n*,	*n*;	*p p*	0	0	0·5
30	N	N	C	*n*, *n* :	*n*,	S.	0	0	0	0·0

Explanation of the notation.

1*st. For the winds.*—C calm. N^2 north wind of the 2d order, 5 being a gale.
$\frac{N}{S}$ north over a south wind, or opposite winds as shown by clouds.

2*d. For the face of the sky.*—S serene. N cloudy. *n*, slight cirrus clouds.
n : nebulous clouds. N– slight stratus clouds.

3*d. For rain storms.*—*p* rain. R^N heat lightning to the north. T storm.

Magnetic Declination (*relative diurnal*).

1859.	4h	6h	9h	12h	3h	6h	9h
Aug. 27	23′, 29″·5	.....	34′, 56″·5	.....	26′, 40″·5	23′, 29″·5	22′, 10″·0
28	34′, 56″·5	.....	47′, 59″·0	.....	29′, 50″·0	41′, 59″·0	66′, 54″·3
29	61′, 47″·5	47′, 6″·0	36′, 14″·0	40′, 0″·5	37′, 34″·0	30′, 50″·0	37′, 34″·0
30	36′, 15″·0	.....	28′, 7″·0	.....	25′, 59″·0	.....	31′, 7″·0

In the night of August 28, *after the Aurora Borealis.*

Hours.	Decl'n.	Barom.	Therm.	Psych't	Hours.	Declin'n.	Barom.	Therm.	Psych't	Sky.
h.	′ ″					′ ″				
9 10	82 52·0	759·0	....	....	9 37	56 39·0	759·2	...	...	
15	76 29·0	....	25·8	23·8	50	64 21·0	....	...	...	
20	71 22·0	759·1	....	....	10 0	65 39·0	....	...	...	
25	58 39·5	....	....	....	10 10	61 47·5	759·4	25·0	24·1	S
29	50 17·5	....	....	....	4 A. M.	61 47·5	....	25·5	23·4	N–
9 34	55 25·0	....	....	....	5 A. M.	32 24·0	....	25·0	22·2	N :

In order to a full understanding of these tables it would be requisite to know also the whole course, absolute and relative, of the various atmospheric phenomena. This would be too long an undertaking, although the means are at command. But from the observations of the four days mentioned, we are able to draw the following conclusions:

1st. The density of the air shows an unusual course. The barometer daily rises, as we know, under the equator (and at Springhill), from four to nine o'clock in the morning, and from four until nine in the evening, and it falls regularly in the intermediate hours. During six years I have scarcely found a single

exception to this law between the equator and Mexico, and the exceptions are very rare at Springhill. Such an exception happened on the night of the Aurora Borealis (Aug. 28) when the barometer remained stationary from three to nine, and rose after nine when it should have fallen.

2d. The temperature fell considerably but not until the next day (29th) under a northwest wind, which had not blown for a long time, and which is ordinarily cold.

3d. The tension of watery vapor in the air was slightly modified. The mean degree of saturation on the 27th and 28th was 21°·35, tension 18·7^{mm}; 29th and 30th was 22°·40, tension 19·9. The 28th at 9 in the evening during the phenomena 22°·26, tension 19·7; 28th at 10 in the evening after the phenomena 23°·47, tension 21·2^{mm}.

4th. The absorption of water by the atmosphere either in an open vase, upon the belvidere of the college, in a room, or in the forest, was considerably more before than after the phenomena.

5th. On the 28th of August there were two diametrically opposite winds. The south, on the earth, and the north, in the upper regions, driving the cirrus clouds to the southward. The 29th the northwest wind prevailed, lowering the barometer.

Without doubt this opposition of winds is due to some extraordinary phenomenon, by which the atmospheric equilibrium was destroyed. I have been able both here and under another sky, to recognize that there is some intimate relation not only between the struggle of the winds and the course of the magnetic currents, but also (the discussion of which is out of place here) to reach an induction in explanation of earthquakes. That fearful phenomenon which I have felt and observed seventy-three times, has always occurred during a calm following a struggle of winds.

6th. Before the Aurora Borealis cirrus clouds (frequently caused by contrary winds) prevailed.

7th. The magnetic declination is the essential point which demands our attention: declination relative, hourly or daily. The normal daily course of the magnetic needle in the northern hemisphere is well known, viz., it moves to the east from four o'clock in the morning till near eleven, and from three till near ten in the evening, and returns to the west in the intermediate hours. In the southern hemisphere the course is opposite.

Near the equator the course is regular and the amplitude restricted. In high latitudes it is more disturbed and the amplitude larger. Three years observations in 4°, 14°, and 19° north latitude, leaving me no doubt upon the accuracy of these maxima and minima. In these latitudes this daily march was disturbed only during earthquakes, and returned to its normal order after the quaking. At Springhill (where I have followed

its daily course five times and even eight times a day according to my occupations, since June, 1858) it has had a regular course depending on the wind from the end of September (1858) until the 17th of August last. In short, from August and in September it has experienced great perturbations which I was tempted to attribute to the influence of the comet of last fall. But the Aurora of August has destroyed my conjectures and cast a new light upon this mystery. Since the 17th of last month (Aug.) the normal course of diurnal declination was scarcely recognizable and consequently I have followed it with the more interest. This disordered movement reached its maximum of observed perturbation at 9 o'clock 10 minutes in the evening of the 28th of August immediately after the auroral phenomena, and its course has since become as irregular as before. The perturbations were finished near 4 o'clock in the morning of the 29th, and last evening (September 1st) the declination had gradually diminished.

By the tables at the opening of this communication we see that the easterly declination between 3 in the evening and $9^h{\cdot}10$ in the night was $53'\ 2''{\cdot}0$. This is the first occasion I have been able to seize upon so considerable an anomaly in so short time. The needle subsequently made two new oscillations up to 10 o'clock 10 min., when I retired.

This morning at 4 the needle had attained another considerable maximum. I ran to the window in time to see the conclusion of another Aurora Borealis. The Aurora of the evening lasted, I understand, until near 3 o'clock, and with a light as brilliant as that of the moon, but without luminous rays, neither was there much diffused purple light. The same cause had produced the same effect, since that moment, (which does not coincide exactly with its maximum) the declination has decreased gradually. The Aurora to-day descended quite to the horizon; it appeared as a little cloud at the northeast and was dissipated at 4 o'clock 30 minutes A. M.

The purple light extended from the north on the night of the 28th of August at an angle of 80°, accompanied by thin sheafs of white light which shot up for a moment from the magnetic pole to the height of *Polaris* (30° 41′).

If observers in different latitudes could have established the conclusion that the opposed aerial movement reigned simultaneously in the atmosphere and developed in the air electric tension, that a calm followed the struggle, and that the Aurora Borealis happened during a calm, they would have made a glorious conquest for science.

But these facts remain yet to be observed. No Aurora Borealis appeared to me in the equinoctial regions as far as lat. 20° from 1847 to 1857. The first which I saw—at Troy, N. Y.,

July 25th, 1857—took place after a rain storm and above a low characteristic cloud during a calm which followed a contest between a south and southeast wind. It was less brilliant than that of August 28th.

The Aurora of August 28th took place in a calm after a struggle between two opposite winds, and that of to-day took place in the calm after a day in which the north wind prevailed in the morning and the south in the evening, but the clouds were immovable and induced the belief that the south wind was low, and that the north wind had ceased.

The Aurora Borealis of the 28th appears to authorize the inference that the light diverged from the magnetic pole, or that it was produced by a radiation of the polar magnetism from the terrestrial magnet. The most brilliant rays which escaped, emanated rapidly from a center below the horizon and that center was in the direction of the magnetic pole. A simple plumb line showed that the rays which reached *Polaris* were not perpendicular beneath that star but were inclined to the east some degrees.

Now the magnetic pole at Springhill is at 6° 28′ east, (mean from several observations). The other inclined rays might have served to determine the place of this center had time permitted my arranging an instrument for taking their sine.*

The low clouds frequently characteristic of the Aurora Borealis did not appear with those of last night. On the 28th there was an expanded and regular stratus in the horizon even to the height of about 8°, with heat lightning from time to time from the northwest.

7. *Observations at Jefferson Co., Miss.* (about lat. 31° 50′, lon. 91°), by an anonymous correspondent—published September 9th in the Port Gibson Reveille.

The Aurora Borealis of Sept. 1, 1859.—My attention was attracted at 11 o'clock last night, (Sept. 1st) to this rare but beautiful celestial phenomenon.

A belt of white light tinged with pink shot up from the northern horizon to the height of twenty or twenty-five degrees and extended east and west nearly the same elevation. Looking to those points I noticed the color deepening until about N.E. and N.W. it attained a bright deep scarlet red, like deeply tinged clouds of our dry-weather sunsets. It shot up in irregular columns arising in places almost to the zenith and spreading out fan shaped and paling as it rose. The white light was stationary except apparently sinking lower or rising higher. The colored

* It was equally impossible to prove that the rays change their direction at the same time that the magnetic needle changes its direction.

portions evolved, rolled, curled, and changed place and color, like the vapors climbing a mountain side. There was a very light surface breeze from the N.N.E. but the tendency of the meteor was to S.S.E. At half-past twelve, it embraced almost the entire northern hemisphere west, and at the height of from 45 to 60 degrees, a broad scarlet belt pointing S.W. to N.E. appeared, 30 degrees long and half as wide, having a dozen bright bars running longitudinally from end to end. It presented every color of the rainbow except blue. At the same time a brownish red column shot up from the N.E. resembling the flame of a huge lamp or candle, vibrating and flickering as though disturbed by wind. No sound was heard.

At 1 o'clock A. M., the white light under and to the left of the polar star was as bright as twilight half an hour before sunrise of a fair morning and extended almost to the zenith. I could see every object in the rooms—the hands of a clock and watch—out of doors the earth had a reddish glare, and every thing was as visible as at half moon, but more distinct as no shadows were cast.

In the white portions the stars were dim but in the colored parts east, west, and overhead were very bright but reddish, like the planet *Mars*. *Aldebaran*, the *Pleiades*, *Orion* and the two dog stars rose during the time and were unusually brilliant. The southern hemisphere looked dark and gloomy from contrast, but was without a cloud. All around the northern horizon there was a thin narrow belt, barely reaching the tree tops of cirro-stratus clouds. The lights were evidently beyond these. I counted seven meteors shooting athwart the heavens, from S.W. to N.E. during the two and a half hours I was up, similar to those of the great meteoric shower of November 13th, 1833, and such as may be seen any fair night between the 10th of August and 1st of December.

We witnessed an Aurora the early part of October 1851, large and brilliant for this latitude, but in no ways comparable to the one of last night. The succeeding winter was long and unusually cold.

SENEX, SR.

Jefferson Co., Miss., Sept. 2d, 1859.

8. *Description of two magnificent Auroræ Boreales observed at Havana, Cuba.* (In a letter from M. ANDREAS POEY, Director of the Physio-Meteorological Observatory at Havana, Sept. 8th, to the Editors.)

The appearance of the Aurora Borealis in the twenty-third degree of north latitude is an event so rare that it naturally produces fear in the common mind, and arrests the attention of men of science. The records and traditions of Cuba show but few examples of the occurrence of this phenomenon. The *first* is

said to have been seen on the 13th of November, 1784; the *second* upon the 14th of November, 1789; the *third* in 1833 (Nov.?); the *fourth* on the 17th of November, 1848; and finally the *fifth* and *sixth* now recorded.

First aurora on the night of Aug. 28th–29th, 1859.—The first appearance of a reddish gleam was seen at 5 minutes past 9 in the evening, which rapidly rose exactly in the north and extended over the space embraced between the N.E. and N.W., reaching the height of *Polaris* about 23°. Some persons, it is said, saw it as early as $8^h\ 45^m$. Its color grew brighter until $9^h\ 30^m$, but from this time it faded to its total disappearance at 10^h. A slightly luminous and whitish tint afterwards covered this part of the sky. But at 1 o'clock it reappeared, reaching again to *Polaris*. It attained its maximum brilliancy at 4^h to $4^h\ 10^m$—its base being of a beautiful carmine red, from which rose divergent rays of a variable diameter, some fire-colored, others whitish, and rising to the zenith, the reddish tint covering a space of 180° from N.E. to N.W. At $4^h\ 20^m$ the aurora disappeared entirely.

Second Aurora on the night of the 1st–2d of September.—This second Aurora having been incomparably more brilliant, more extended, and more permanent than the first, it seems best to notice the details of its development with care, as points of comparison with observations in higher latitudes. This aurora was not visible before $12^h\ 30^m$, and from that moment to 5^h A. M. I followed all its changes. From $12^h\ 30^m$ to $12^h\ 45^m$ it spread towards the east, and afterwards towards the west, then turning yet more towards the east with white rays which grew pale at the extreme west. From 12^h to 1^h after the white rays became extinct a portion of the east appeared of a beautiful fire-red. A part of the west became also more flaming, and the summit of the arch, poorly defined, attained the height of *Polaris*, with a movement of translation toward the east. At 1^h a brightness streamed from the north moving towards the N.N.E., defining by its light the outlines of cumulus clouds, of the horizon, of the sea, and the entrance of the fort. As this brilliancy increased and rose above the horizon its tints passed into light blue, involving the red portion at the northeast, and presently it began to fade out. The upper red segment rose considerably above *Polaris*. The illumination faded towards the northwest and embraced the whole of the auroral base; afterwards it rose again to the height of 12°. White rays with red and blue were then seen towards the west, which dilated longitudinally, oscillated laterally, were extinguished and resumed their brilliancy again by turns. The intensity of the illumination increased towards the east, and the red segment towards the west became more brilliant and more extended, until at the E.N.E. it

reached its maximum of brilliancy. At 1^h 15^m these rays were spread over the whole Aurora. The illumination attained to the E.N.E. in the space of three minutes, then it extended to the N.N.W. The east and still more the west then became very red. The illumination reappeared next at the east. The whole Aurora now became very red with rays to the north and west. This shade spread almost to the zenith. The fire-red of the west remained constant. The general depth of the Aurora faded while the whitish and reddish rays became more brilliant. But it was from 1^h 30^m to 3^h 15^m that the half hemisphere of the north from east to west was completely covered by a rich red tint, more orange than carmine, the gently arched summit of which passed the zenith towards the northeast, attaining the height of 100 degrees, accompanied with whitish rays and also with the red rays, more vivid then the general tones of the segment rising to the zenith, yet without passing it. At 2^h the Aurora had attained its highest magnificence. The heavens then appeared stained with blood and in a state of complete conflagration. At a vast distance above the upper red segment appeared a second whitish segment which rose 23° above the horizon, while the upper red segment spread for 100° to the northeast and towards the constellation of Orion. The illumination whose different phases I have followed then constituted a white arch, the central and visible base of the Aurora above a bed of cumulus clouds which reached 8° above the horizon. At 2^h 45^m the two segments or arches of the Aurora declining toward the horizon, the lower white one first disappeared at 3^h 15^m A. M. From 3^h 30^m to 4^h the general reddish tint disappeared and reappeared many times, but remained more intense towards the northeast. From 4^h to 5^h it gradually declined as the dawn commenced. At last the Aurora disappeared at 5^h A. M. in the prolongation of the magnetic meridian where it made its first appearance. From 1^h the west was constantly more flame-colored than the east.

These two Auroras have manifested the following peculiarities worthy of remark. 1st. The reappearance on the third night. 2d. Their magnificence: in height considerably more than 100°, in extent over 180°, their long continuance to day-dawn here under this latitude of 23°. 3d. The absence of an obscure lower segment although it might readily have been covered with the cumulous clouds which rose 8° above the horizon: above all, the expanse of the Aurora, a segment the extent of which has not been well established. 4th. The great height of 23° of the luminous segment or lower white arch visible only in the second Aurora. 5th. The rays or jets of light, some of which rose diverging from a point very far below the horizon, while others springing from the centre of the Aurora appeared to converge

slightly toward the zenith. Again they vanished for an instant to reappear over other points, some having a brilliant red, others a dense white mass with a feeble lateral pulsation and an alternate elongation and shortening. Sometimes the base of the rays was most brilliant and most deeply red colored, soon again the deepest and most brilliant color was on the upper extremities. 6th. The reiterated movement of translation of the whole aurora from east to west, followed by retrocession in an opposite direction, movements noted as being very rarely observed.

Space does not allow me to notice the concomitant phenomena which were produced, which from their importance will be the object of the next communication which I shall have the honor to address to the Academy. I enumerate the principal points observed. 1st. There was no noise in the aurora. 2d. The freely suspended needle of Marianini's Ré-Electrometer manifested not the slightest oscillation. 3d. The gold leaf electroscope of Bohnenberger gave no sign of atmospheric electricity. This neutrality of the magneto-electric force in the presence of so magnificent an Aurora Borealis is worthy of remark, for these two pieces of apparatus constructed by M. Ruhmkorff have great sensibility. 4th. There was no trace of polarization in the auroral light but very sensibly in its reflection upon the surface of the sea and upon the opposite clouds. 5th. It was perfectly calm. 6th. The temperature and barometric pressure were as usual. 7th. Two days after the Aurora the barometer rose from a half millimeter to one millimeter, following the height of the diurnal tide, and a northeast breeze set up.

9. *Observation at San Francisco, California;* by Dr. JOHN B. TRASK. (In a letter to the Editors, dated Sept. 1st, 1859.)

On the night of the 28th of August, at the hour of 10 o'clock, and continuing from that hour until near daylight we had for the first time in ten years in California a fine display of the Aurora. The sky was illuminated from the northwest to the northeast, with a flood of crimson light extending to the zenith, through which the whiter and yellow columns would start at varied intervals. It was a magnificent display and will compare favorably with the best varieties of your wintry months.

10. *Height of the base of the Auroral curtain, Aug.* 28.

The minimum altitude above the southern horizon of the lower margin of the meridional part of the auroral curtain, seen during the display of Aug. 28th, previous to 9 P. M., was determined independently by Prof. C. S. Lyman and by Mr. E. C. Herrick at New Haven, and by Prof. A. C. Twining at West Point, N. Y. These three determinations were made at about

the same absolute time (about $8^h\ 40^m$ New Haven time) and range from 10° 40′ to 12°. Fortunately, a like observation was made at Philadelphia, Pa., (N. lat. 39° 57′), by Mr. Chas. J. Allen, where and at Burlington, N. J. the display was observed by Mr. Allen and by Messrs. Benj. V. Marsh and Samuel J. Gummere. Mr. Allen found this minimum altitude at Philadelphia to be about 22½°. Assuming that the curtain was for a moderate distance parallel to the earth's surface, and that the observers saw the same curtain, it follows that the lower visible margin thereof was about forty miles above the earth. The probable error of this result seems to be quite small, yet it is highly desirable that the conclusion should be tested by observations taken at places between New Haven or West Point and Philadelphia and beyond, as far as Annapolis or Washington. The elevation of auroral belts observed in New England has been found to exceed one hundred miles, but the relation between auroral belts and streamers is little understood.

11. *Appeal to Observers.*

It is conceded that there is much connected with the auroral light which has not yet been fully explained, but it is unquestionably one of the most important of all meteorological phenomena, and its full explanation would probably bring with it the explanation of a large number of other phenomena, such as the origin and laws of atmospheric electricity, as well as of terrestrial magnetism. It is then of the highest importance to science that we should ascertain what the aurora is. The Aurora of Aug. 28th and following days affords a peculiarly favorable opportunity for deciding this question, and it is therefore important that this Aurora be thoroughly investigated. A thorough investigation of a single Aurora promises to do more for the promotion of science than an imperfect investigation of an indefinite number. It has been decided therefore to make a strenuous effort to investigate the laws of this auroral exhibition. For this purpose we need a careful collection of all the observed facts; and it is earnestly requested that every person who made accurate observations of the Aurora of Aug. 28th would communicate them to us for publication. This appeal is addressed to men of science in every part of North America where an Aurora was seen on the night of Aug. 28th. It is also addressed to observers on the ocean, and indeed throughout every portion of the globe, with the sole exception of Europe; for we assume that the appearances in Europe will be fully reported through the European journals. It is not improbable that this auroral exhibition may have been witnessed throughout the principal part of the northern hemisphere; and it is of great importance to know how far it did extend.

In order to render the communications of observers more definite and precise, we will briefly indicate the kind of information we desire.

We desire an accurate but concise description of all the phenomena with the *exact time* of their occurrence.

1. If a dark segment was seen resting either on the northern or southern horizon, or both of them, its altitude and position should be accurately stated.

2. If the streamers were seen to converge to a single point of the heavens, this point should be accurately located and the time of observation given.

3. If any single phenomenon (such as a detached luminous arch extending from the east to the west horizon) was so conspicuous as to be easily identified, it is important to have an accurate statement of its position and the altitude of its vertex, with the time of its formation and disappearance.

4. Was the Aurora seen in the southern half of the heavens, and how near the southern horizon did it extend?

5. Describe the color of the light, as well as its intensity.

6. If the Aurora exhibited any great variations of brilliancy it is important to know the times of least as well as the times of greatest brilliancy.

7. Did the Aurora exhibit any sudden flashes? Were there any pulsations like waves of light rushing up from the horizon?

8. If any observations were made showing the influence of the Aurora upon the magnetic needle, it is desirable that they should be communicated in detail.

9. The kind and degree of influence exerted upon telegraph wires.

10. Was any motion of translation observed in the Aurora, and if so, in what apparent direction and with what velocity?

It is proposed to publish in future numbers of this Journal, the most important part of whatever information may be obtained as the result of this appeal; and it is intended to present the facts in such a form that each one will have all the materials which are necessary to conduct the investigation for himself. After all the facts have been communicated, it is proposed to present an analysis of the whole, with some speculations on the general subject of Auroras. Observers may forward their communications either to the "Editors of the Journal of Science, New Haven, Ct.," or to "Prof. Elias Loomis, New York City," who has consented to undertake the discussion of the phenomena.

Postscript.—Any exact data, relating to the remarkable auroral arch of April 29, 1859—mentioned by Mr. Herrick on p. 154 of this volume, will *be very acceptable.*

ART. XLIII.—*Account of several Meteoric Stones which fell in Harrison Co., Indiana, March 28th*, 1859; by J. LAWRENCE SMITH, M.D., Prof. Chemistry, University of Louisville, Ky.

HAVING become acquainted with a remarkable phenomenon accompanied with a fall of stones that occurred in Harrison Co., Indiana, I immediately made enquiries concerning it, expecting to visit the neighborhood on an early occasion; but I was fortunate enough to learn of some admirable observations made by Mr. E. S. Crosier, and in fact so complete were his examinations that I clearly saw that no additional information could be elicited by my resorting to the spot. Mr. Crosier obtained for me the various stones that had been found, and also put himself to much trouble to obtain the information desired.

The stones fell on Monday the 28th of March, 1859, and Mr. Crosier visited the place on the Saturday following; in the mean time the following stones were discovered:

No. 1,	weighing	19 oz.,	discovered by	Goldsmith.
2,	"	4½ oz.,	" "	Crawford.
3,	"	420 grains,	" "	Lamb.
4,	"	167 "	" "	Mrs. Kelly.

The following are the facts elicited by enquiry on the spot.

The time at which it occurred (4 o'clock in the afternoon) rendered the phenomenon of ready observation. The area of observation was about four miles square, and wherever persons were about in that area, the stones were heard hissing in the air, and then striking on the ground or among the trees.

Hardly a single person in the immediate vicinity of the occurrence saw any flash or blaze as was noticed by all who heard the report from a distance.

Three or four loud reports, like the bursting of bombshells, were the first intimations of anything unusual. A number of smaller reports followed, resembling the bursting of stones in a lime kiln. The stones were seen to fall after the first four loud explosions. Those who happened to be in the woods or near them heard the stones distinctly striking amongst the trees. In some places the noise of the falling stones in the woods alarmed the cattle and horses in the vicinity, so that they fled in terror. A peculiar hissing noise during the fall of the stones, was clearly heard for miles around. A very intelligent lady described it as very much like the sound produced by pouring water upon hot stones. The air seemed as if all at once it had become filled with thousands of serpents.

Mr. Crawford and his wife were standing in their yard at the time, and hearing a loud hissing sound overhead, on looking up

a stone (No. 2) was seen to fall just before them, burying itself four inches in the ground, they dug it up immediately, but it did not possess any warmth; it had a sulphurous smell. Another which they did not find fell near them, when they thought it prudent to retire to the house.

Two sons of John Lamb were in the barn yard attending to the horses, when their attention was called to a loud hissing noise above, and immedialely a stone (No. 3) fell just at their feet, penetrating the hard tramped earth some three or four inches, and they state that it was warm when taken from the ground. Another fell in a peach tree near by, but the ground being newly plowed they were unable to find it.

The largest stone (No. 1) was not obtained until the following day, being dug up beside a horse track on the streets of Beuna Vista, Indiana, it having penetrated the hard gravel to the depth of four or five inches. It had a strong smell of sulphur. The last (No. 4) was dug up by Mrs. Kelly the following day in her yard.

These four aërolites, owing to their being buried deeply in the ground, are all that have been found up to this time. None have been found or were heard to fall over a greater area than four miles square.

These are all the details that I have been able to gather connected with this fall of meteoric stones. They are highly interesting and probably as accurate as it is possible to obtain.

Nos. 1, 2 and 3 and a fragment of No. 4 were placed in my hands for examination. Nos. 1, 2 and 4 are cuboidal in shape, No. 3 was considerably elongated; they are all covered by a very black vitrified surface, equally intense on every one and on every part of each one, and when broken show the usual grey color of stony meteorites interspersed with bright metallic particles.

The mean specific gravity is 3·465; when broken up and examined under a glass four substances are distinguishable: metallic particles, dark glassy mineral, dark dull mineral, white mineral matter.

Examined as a whole the following elements were found in it: iron, nickel, cobalt, copper, phosphorus, sulphur, silicium, calcium, aluminum, magnesium, manganese, sodium, potassium, oxygen.

By the action of the magnet it was separated into

Nickeliferous iron,	4·91
Earthy minerals,	95·19
	100·00

The earthy minerals acted on by warm dilute hydrochloric acid, thrown on a filter and thoroughly washed, then treated

with dilute caustic potash, to dissolve any silica of the decomposed portion that was not dissolved by the acid, gave

Soluble portion,	62·49
Insoluble portion,	37·51

The metallic portion separated from the earthy part gave

Iron,	86·781
Nickel,	13·241
Cobalt,	0·342
Copper,	0·036
Phosphorus,	0·026
Sulphur,	0·022

The earthy portion freed from metal gave

Silica,	47·06
Oxyd iron,	26·05
Magnesia,	27·61
Alumina,	2·35
Lime,	0·81
Soda,	0·42
Potash,	0·68
Peroxyd manganese,	trace, not estimated.

It is clear from the analyses as made out, that these meteoric stones contain the constituents frequently found in similar bodies, namely: nickeliferous iron, phosphuret of iron and nickel, sulphuret of iron, olivine, pyroxene and albite; and in about the following proportions.

Nickeliferous iron,	4·989
Schreibersite,	·009
Magnetic pyrites,	·001
Olivine,	61·000
Pyroxene and albite,	34·000

I have no intention to enter into any speculations in relation to these meteoric stones, although I have accumulated some additional matter on the subject since my memoir on meteorites published in the Am. Jour. Science, vol xix, pp. 152 and 322, intending to reserve their publication for a future occasion.

Louisville, Ky., Oct. 1, 1859.

Art. XLIV.—*Geographical Notices.* No. IX.

The Inland Seas of Africa. Sources of the Nile.—The Royal Geographical Society of London have awarded the Founder's Medal for the current year to Capt. R. F. Burton, of the Bombay army, for the discovery of the great lake of Tanganyika, in Africa, the more northern lake being discovered by his coadjutor, Captain Speke. The journeys of these bold explorers have been previously mentioned in this Journal. On June 26, 1857, the two travellers left Zanzibar for the interior

and succeeded in reaching the great lake Tanganyika, 300 miles long, and 30 broad, which lies about 700 miles from the coast. Captain Speke proceeded from Unyanyembé to another vast inland lake called Nyanza, the south end of which was fixed by him at 2° 30′ S. lat., and 33° 30′ E. long. It is estimated to have a width of about 90 miles, and is said to extend northward for upwards of 300 miles.

Sir Roderick I. Murchison, President of the Royal Geographical Society of London, in his annual address gives the following account of the discoveries of Burton and Speke which are particularly important in reference to the long disputed problem of the Sources of the Nile.

"Returning to Europe from Aden, both Captains Burton and Speke sought and obtained employment in the Turkish contingent of the allied armies operating in the Crimea. Thrown out of their military career by the peace, they returned to the east coast of Africa, with the view of exploring the country from the coast of Zanzibar as far inland as might enable them to ascertain the real geography of the interior in that latitude.

"Aided by the late Colonel Hamerton, our meritorious consul at Zanzibar, and by Seyd Majid, the second son of the Imaum of Muscat, now the Prince of Zanzibar, the travellers made an experimental journey from that place on the coast to Fuga in the mountain country of Usambara. In their last and great expedition they again proceeded from Zanzibar. Their party consisted of twelve Belooches furnished by the kindness of the Sultan, some negroes who had been slaves, and asses for the transport of goods and for riding. Passing over the delta and low hilly country called M'rima, they entered the mountainous coast range at about 120 miles from the coast. This range which rises to a maximum altitude of 6,000 feet, with a width of about 90 miles, is chiefly composed of sandstone and crystalline rocks, the true character of which will be ascertained when Captain Burton's specimens arrive.

"Descending from the coast range to the great interior plateau land, at a lower level, and travelling over some poor lands, they reached a rich country in which knolls or bosses of granite and basalt rise up like rocks in an ocean. The country is exclusively peopled by negroes, none of whom are Mahomedans, as are the Somaulis and trading Arabs of the coast.

"Like the Negroes described by Livingstone, they have no special religion, trusting solely to good and evil spirits. Such of them as have sultans are on the whole peaceable, fire-arms being rare among them. Their country produces cotton, tobacco, maize, sweet potatoes, a great variety of pulses, manioc, yams, plantains, and melons; they manufacture iron, cotton fabrics, have abundance of cows and goats, and live in comparative comfort.

"From Kazé, in Unyanyembé, a spot where the Arab traders have established a sort of mart, and where articles from the coast are bartered for ivory and slaves, the travellers moved westerly until they reached the long inland mass of water trending from S. to N., which has been styled Uniamesi and Ujiji, but the real name of which is Tanganyika.

"This lake was found to be 1,800 feet only above the sea, or about half the average height of the plateau land west of the coast range. It has a length of about 300 and a breadth of from 30 to 40 miles.

"This great internal mass of water was determined to be an insulated depression into which streams flow on all sides. It was crossed by Speke in the centre, and navigated conjointly with Burton to near its northern end, where it is subtended by mountains which were estimated to have a height of from 6,000 to 7,000 feet within the range of the eye.* Its waters are perfectly *fresh* and peculiarly agreeable to drink, and it abounds in delicious fish, whilst its banks are grazed by red oxen of large size, some of them having stupendously long horns. Oxen are indeed common over nearly all the region examined, for the *tsetse fly*, the scourge of the more southern African countries, in which Livingstone travelled, is unknown.

"A singular phenomenon of blindness affected for some time both the travellers. Whilst exposed in the arid, hilly coast range, and also in the plateau land, to a fierce and glaring sun, their sight was unaffected; but on descending into the verdant, well watered, and rich lacustrine expanse of Tanganyika their sight was dimmed, and gradually they became almost blind—their recovery being slow and imperfect. It was this calamity alone which diminished the number of astronomical observations made by Captain Speke, who lost no opportunity of fixing the latitude and longitude of numerous positions.

"When returned to their chief central station in Unyanyembé, Speke, thriving upon hard field work, left his invalid companion

* Since this Address was delivered, the British Museum has acquired a curious, large, old Portugese MS. map of the world, on the Mercator's projection, made by Antonio Sances, in 1623, which shows how much general knowledge of the interior of Africa was possessed at that period by the Portugese. On this vellum map, the author distinctly places one large body of water in the centre of Africa, and in the parallel of Zanzibar. Although all the details are inaccurate, and he makes the Congo flow out of this lake to the west, and another river (representing probably the Zambesi), which is called R. de St. Yurzes, from the same to the S.E., still the general notion of great internal waters is there put forth.

Chevalier Pertz has recently discovered in an old MS. in the Royal Library at Berlin that, even in the year 1291, two Genoese navigators, Teodosio Doria and Ugolino Vivaldi, sailed for a certain distance down the West Coast of Africa. Their ships were called *Sant' Antonia* and *Allegranza*, and the last-mentioned name has, indeed, remained attached to the most northern of the Canary Islands. It has been erroneously stated in some journals that these Genoese navigators sailed round the Cape of Good Hope.—*June* 20, 1859.

in order to reach the great lake Nyanza, the position of which had been pointed out to him by the Arabs, who asserted that it was much longer and larger than Tanganyika, from which it is separated by about 200 miles. In this journey Captain Speke, accompanied by his faithful Belooches, passed through the district where the chief iron works of the country are carried on; the native blacksmiths smelting the ore with charcoal.

The great lake Nyanza was found to occupy the position assigned to it by the Arabs, and the E. longitude being very nearly that of Kazé, viz., 32° 47′,* its southern end was fixed at 2° 30′ S. lat. Ascending a hill and looking northwards, the enterprising traveller could discern nothing beyond the islands termed Ukerewe, but a vast interior sheet of water, which, according to those Arabs, whose information had hitherto proved correct, extended northwards for upwards of 300 miles. Captain Speke, who estimates the breadth of this internal sea at 90 miles near its southern end, further ascertained that it is fed not only by streams flowing from the mountains which separate it from Lake Tanganyika, but also by other streams, many of which meandering in the lower plateau to the west of the lake, constitute, like the internal rivers described by Livingstone, a watery network which when supersaturated by the rains burst and overflow the country.

"Seeing that this vast sheet of water extends due northwards, ascertaining by his thermometer that it was nearly 4,000 feet above the sea, and knowing that its meridian was nearly that of the main course of the White Nile, Captain Speke naturally concludes that his Nyanza is the chief source of that mighty stream on the origin of which speculation has been so rife. This view seems to coincide with the theoretical speculation laid before this Society by myself in preceding years, and is in accordance with the data worked out by Livingstone, of a great interior watery plateau subtended on its flanks by higher lands, and from which interior plateau the waters escape to the sea by favoring depressions.

"The physical configuration of the land to the east of the great Nyanza Lake is indeed strongly in favor of this view. On that side, and at a distance of about 200 miles from its banks, the eastern coast range of Africa rises from 6000 feet in the latitude of Zanzibar (where it was passed by our travellers) into a lofty range or cluster, of which Kilimanjaro forms the southern and Kenia a northern peak.

"If the assertion of Rebmann and Krapf be accepted, that perpetual snow lies on those mountains, though the able critical essay of Cooley† had induced me to suppose that these mission-

* Lunar observations were made at this station.

† *See* Cooley's "Inner Africa Laid Open," p. 126.

aries might have been somewhat misled, the summits of these mountains must have an altitude of upwards of 18,000 feet. At all events it is granted that they are the highest points of this coast range. Now, whilst streams descending from the western flank of Kenia (Kilimanjaro is too far to the south) may probably be feeders of the great Nyanza Lake, which occupies a long lateral north and south depression in the plateau on the west, we know from its meridian as now fixed, that the direction of this fresh-water sea points directly to Garbo, the spot in latitude 3° north reached by M. Ulivi, as related by Brun-Rollet, a Sardinian, who had established a trading post at Belenia in latitude 4° 50′ north, on the White Nile in 1851. The north and south direction of the Nyanza, which Speke believes to reach from south latitude 2½° to 3° 30′ north latitude, brings us in fact beyond the Garbo of Ulivi and Brun-Rollet.*

"The variations which occur in the height of the waters at different seasons, in the interior plateau-country surrounding the great lake, were strikingly described to Captain Speke by the Arabs, when they assured him that at one season of the year the water lilies were so abundant as to enable the traveller to pass over a wide river by treading on their broad and thick floating leaves, showing how flat the country must be, and how sluggish are the streams.

"Let us hope that when re-invigorated by a year's rest, the undaunted Speke may receive every encouragement to proceed from Zanzibar to his old station, and thence carry out to demonstration the view which he now maintains, that the Lake Nyanza is the main source of the Nile. Considering the vast difficulties which beset the traveller who attempts to penetrate southwards by ascending the Nile, it seems to be preferable that the effort should be made from Zanzibar, where Captain Speke is sure of being heartily supported by the Sultan, and whence, taking men on whom he could rely, he can certainly calculate on reaching the Lake Nyanza in good plight, for that zone of Africa which he has passed through is now ascertained to be occupied by a much more tranquil people than those of the countries north and south of it.

"On former occasions I contended that the periodical overflow of the waters from the internal fresh-water lakes was explicable by the fact, that at certain periods of the year, differing of course in different latitudes, the rain-fall of several months would at last so supersaturate the interior plateau-lands and lakes as to produce periodical annual discharges. That the lofty mountains of

* M. Jonard has analyzed and compared the discoveries of M. Brun-Rollet, who gives some information derived from De Angelis, who resided at Belenia in 1851, which is worthy of attention. But speculations founded on such uncertain data are of no great value.

the coast range, of which Kenia is the chief peak, may throw off certain feeders of the White Nile, just as the mountains of Abyssinia feed the Blue Nile, must probably be the case; but whilst it may be admitted that little snow may occupy the peaks or summits of Kilimanjaro and Kenia, I am of opinion with the learned Cooley* that the elevation and mass of these mountains are not such as would sustain a vast range of snow and ice, the melting of which would account for the annual rise of the Nile. Even if it be assumed that this is really a snowy chain, the exact periodical rise of the Nile could never be caused by a periodical melting of its snows, since the power of the sun under the Equator is so nearly equable throughout the year, that it must operate in filling the streams which descend from the mountains with pretty much the same amount of water at all seasons. The great phenomenon of the periodic rise of the Nile is, it seems to me, much more satisfactorily explained by the annual overflow of a vast interior watery plateau, which is, thanks to Captain Speke, ascertained to have an altitude much more than adequate to carry the stream down to Khartum, where the Nile is believed to flow at a height of less than 1500 feet above the sea; and as the river below that point passes through an arid country, and is fed by no lateral streams, it is to the southern, central, and well-watered regions that we must look for the periodic supply.

"On consulting Captain Speke respecting the rainy season of that part of the interior of Africa which lies between Ujiji and Unyanyembé, I find that in about east longitude 30° and south latitude 5° the rains commence on the 15th November and end on the 15th May, during which period of six months they fall in an almost continuous downpour. Farther northward, where the Lake Nyanza lies, the rainy season, in the common order of events, would commence, he supposes, somewhat later, and probably at a time which will account for the periodical rise of the Nile at Cairo on the 18th June. In support of this view Captain Speke states that the river Malagarazi, which drains the surplus waters from the southeast slope of the mountains between the Lakes Nyanza and Tanganyika, when first crossed by the expedition, was within its banks, but on the 5th June it had quite overflowed them and constituted a stream 100 yards broad, run-

* This acute scholar has shown his power as a comparative geographer by a close analysis of the *quæstio vexata* respecting the Nile of the ancients, and shows that the true Nile of Ptolemy was the Blue Nile, which descends from the mountains of Abyssinia. He also shows that the great lakes of the Nile of Ptolemy are at the Equator—a view now confirmed by the researches of Speke. As to Kilimanjaro, he says it is "an insulated mountain in a sea-like plain, and on a fifth scale of the magnitude required for maintaining perpetual snow near the Equator." *See* also his work "Inner Africa Laid Open," in which he explains the existence of a great sea or lake in the interior of Eastern Africa.

ning westwards into the depressed lake of Tanganyika. Now, as according to the Arabs, and other intelligent men with whom he conversed, the whole region to the northward of the mountain in question, *i. e.* beneath and to the north of the Equator, is an extensive marshy plateau, intersected by some large and innumerable smaller streams, all feeders of Lake Nyanza, we have only to suppose that at the *close* of the rainy season the great discharge occurs, and we then have in these data strong grounds for believing, that the theory which I ventured to propound to this Society as the best explanation of the overflow of the Zambesi of Livingstone, as well as of the Congo and other African rivers, will also be found to be applicable to the Nile.

"In concluding this notice of the labors destined to clear up the problem of the real sources of the Nile, I must express my thanks to Mr. M'Queen for his efforts to collate all the data concerning the ascents of the White Nile from the expedition sent by Mahomed Ali in 1839 to that of Don Angelis, which Brun-Rollet accompanied in 1851, and when the party reached 3° 50′ north latitude, 31° east longitude. Adding to information obtained from natives and Arabs, and citing Lucan and other ancient authors to the same effect, Mr. M'Queen contends that a lofty mountain to the southeast of the cataracts of Garbo, the last station of Brun-Rollett and his companions, which must be Kenia, is the chief feeder of the White Nile, and that the river Tubesi, spoken of by the African King of Bari, is really the Tumbiri heard of by Dr. Krapf.

"Now, even if this view be sustained, it seems to me to be quite compatible with the fresh knowledge obtained by Captain Speke, and his inference, that the Nyanza is the chief feeder of the White Nile. For the southern extremity of this great inland lake is but 2½° south of the equator, whilst its western shore is probably not more than 150 miles from the lofty mountain of Kenia. Hence, seeing that Nyanza is about 4000 feet only above the sea, and that the eastern mountains, under the equator, are much higher, there is every probability that this vast sheet of water may be fed from the east by streams flowing from Kenia, as it is ascertained to be supplied from the southwest and west by other rivers flowing from the mountains, which separate this high sheet of water from the depressed Lake Tanganyika.*

"If then it should eventually be proved, that the Lake Nyanza contributes its annual surplus waters to the White Nile, so

* Mr. Edw. Heneage informs me that Botero, in his "Relationi Universali" (Venice, 1640), says that the eastern Nile flows out of a lake 220 miles long, situated under the equator; and he places the sources of the western branch of that river S. lat. 9°, close to the sources of the Zaire or Congo, and what may also be intended for the origin of the Zambesi.

may it then be fairly considered as the main source of the great river; the more so when we see that its southern end is farther to the south, or more remote from the embouchure, than any other portion of the Nilotic water-parting.* On the other hand, the high mountains which flank the great stream on the east, and probably supply it with some of its waters, may by other geographers be rather viewed as the main and original source. These are the only remaining portions of the great problem which have to be worked out—a problem which it has been the desideratum of all ages to unravel, and one which, according to Lucan, made Julius Cæsar exclaim, that to gain this knowledge he would even abandon the civil war†—a problem which Nero sent his centurions to determine, and which, by the last discovery of Captain Speke, seems certainly now to approach nearly to a satisfactory solution."

WARREN'S MEMOIR TO ACCOMPANY A MAP OF THE WESTERN TERRITORY OF U. S.—We have already referred to the admirable map by Lieut. G. K. Warren, U. S. Topog. Eng., prepared to illustrate the result of the various expeditions of the government to the teritory west of the Mississippi river.‡ We have now received a volume from the pen of the same officer, illustrative of the map. It is printed from the advance sheets of the eleventh volume of the Pacific Rail Road Surveys. This memoir is not limited to a description of the map, and an account of its method of compilation. It gives in a condensed form a review of all the exploring expeditions in the West since 1800.

The first period extends from 1800 to 1832, beginning with the travels of Lewis and Clarke and concluding with those of Hardy, Ross Cox, Allen, and Schoolcraft.

The second period, from 1832 to 1844, includes the exploration of Bonneville, the early discoveries in Great Salt basin, Nicollet's hydrographical survey of the upper Mississippi, the beginning of Frémont's travels, and other reports and maps of army officers, the topographical engineers.

The third chapter is devoted to more than twenty expeditions, of greater or less importance undertaken between 1843 and 1852, almost exclusively under the patronage of the U. S. Government.

* Although both White Nile and Blue Nile are fed by many affluents, the remarkable physical feature of the great stream below their junction is that in a course of 1200 miles it is not increased by the addition of any lateral waters. On this feature, as well as on the parallelism of its course to the great N. and S. depression of the Red Sea, on the fertilizing powers of its waters, and on the periodicity of its flood, the reader will do well to consult the article "Mediterranean Sea," Edinburgh Review, vol. cvi., which is from the pen of our accomplished associate Sir Henry Holland.

† "Spes sit mihi certa videndi
Niliacos fontes bellum civile relinquam."—LUCAN, *Book* 10.
(As quoted by Mr. M'Queen.)

‡ This Journal, vol. xxvii, 386, 1859.

In 1852, the various important Surveys for the Pacific Rail Road commenced, and a review is given of their several routes and objects. To this historical report, succeeds a statement of the method of completing the general map before alluded to and some remarks on the topography of the region west of the Mississippi River.

Four reduced copies of early maps of the territory west of the Mississippi are included in the Memoir; first, of a map published with Winterbotham's History in 1796; second, of Rector and Roberdeau's map, 1818; third, a part of Finley's North America, 1826; and finally, of Bonneville's map which appeared in 1837.

The Memoir and the Map taken together are an important accession to our knowledge of the physical geography of this continent and will be of constant service not only to men of science, but to statesmen and all others who are interested in the structure and resources of the immense territory which lies to the west of the Mississippi river. In this connection, we may call attention to the tenth volume of the surveys of the Pacific Rail Road which has just been distributed, containing Part III. of the report on "Zoology," prepared by Prof. Spencer F. Baird of the Smithsonian Institution.

HISTORY OF THE DISCOVERY OF AMERICA. ATLAS OF KUNSTMANN, SPRUNER AND THOMAS.—In striking contrast with the work we have noticed by Lieut. Warren and its illustrations of recent discovery, we may mention the republication of early maps of this continent (chiefly the Atlantic coast,) which has been just made under the auspices of the Bavarian government. A few copies of this truly magnificent atlas have been received by Messrs. B. Westermann & Co., in New York. In place of comment of our own, we translate from the Berlin *Zeitschrift für allgemeine Erdkunde*, the following condensation of the plan of the compilers.

F. Kunstmann, K. v. Spruner and G. M. Thomas have published an Atlas on the history of the discovery of America, which consists of thirteen most interesting sheets printed in fac-simile from those most valuable chartographical documents, which are found in the Royal Library, the Library of the University and the Military Conservatory at Munich. F. Kunstmann in his learned treatise "Die Entdeckung Amerika's, which precedes the text explanatory to the charts, says, "The charts commence in the 14th century, when they first appear as the product of independent inquiry, and follow the progress of the voyages of discovery, the results of which are for the most part deposited in them. Our knowledge that the Azores were discovered in the 14th century, we owe solely to the charts, as we have no other historical accounts concerning them. The history of the Canary Isles which is at first but fragmentary, is also completed by them.

They also enlighten and increase our knowledge in relation to the discoveries in America generally. In these charts we also have original records for the history of the voyages of the separate nations. They commence with the voyages of the Italians, who first set out independently, then in the service of Portugal, Spain and England, leaving us those grand drawings of the globe, which were continued and finished by other nations. These accordingly preceded the systematic descriptions of the world, which furnished us with but poor and scanty information in regard to the discovery of America, although the charts had already presented an almost complete picture of what was then known." Of the thirteen sheets of the atlas the first five relate to the time of Magalhaens's voyage of discovery down to its completion; the following eight explain the history of discovery to the end of the 16th century. We will here attempt to show the importance of this publication by a short extract from F. Kunstmann's explanations to the charts.

The first sheet the contents of which Schmeller had made known in his academical treatise, "On several older Sea-Charts in Manuscript," (December, 1843)—is written in the Portuguese language and bears the name of its author at its head, Pedro Reinel a fez. Barros (Dec. 1, lib. 3, c. 12) mentions a Pedro and a Rodrigo Reinel. The former was sent in 1487 to the negro-chieftain Mandimansa at the Gambia. Rodrigo is mentioned in the same year as a merchantile agent in the Oasis Ouadan on his way from Arguim to Timbuctu. In the following century, the Portuguese Sebastian Alvarez, mercantile agent at Sevilla, mentions in his account of the enterprises of Magalhaens (made July 18, 1519 to King Emanuel of Portugal,) two Reinels, father and son, omitting however their christian names. "I saw, he says, the Moluccan Islands on the globe and the chart, (en la poma y carta) which Reinel the son has made here; both were yet incomplete, when his father came to him, who finished them and put the Molluccan Islands in." For this master were also made all those charts which Diego Ribero completed, who was the assistant and probably also the pupil of the older Reinel; hence the conformity in that part of Pedro Reinel's chart which represents North America, with the northern part of America in Diego Ribero's chart. The former contains in the new world, only the eastern coast of Newfoundland and our present Labrador up to Hudson's Bay, in a continuous drawing agreeing with the report given by the Venetian ambassador Pasqualigo, (October 19, 1501) on the second voyage of Caspar Cortereal in the year 1501, from which but two Caraveles with sixty natives, without Cortereal, returned. Soon after this voyage the above chart was probably worked out in Portugal.

The second chart represents the notions of that period in which North America was believed to consist of a number of islands between which, it was hoped, a passage might be found to the Molluccas. We find here the "Terra de Corte Reall" completely separated and the terra de lauorador (Labrador) as a complete island. North of Great Britain the "Terra de Uresland" (Vresland, Frisland) is situated, a name which according to Zahrtmann is derived from Ferris land as English mariners called the Faroes. Besides this, the sheet contains the West Indies (le Antilie) the northern and part of the eastern coast of South America, the latter up to Rio de Cananor, as according to Peschel, it is often written instead of Rio de Cananea, on the Italian charts published since 1507, which were copied after Ruysch.

On the third chart, which only marks the discoveries of the Portuguese, of which the Spaniards take no notice, Labrador, (or Groenland, and the "Terra de Corte Reall" appear also as separate continents in accordance with the discoveries of C. Cortereal in his two voyages in the years 1500 and 1501. As a third continent, is seen the eastern coast of South America from Cape Roque up to R. Cananea, in conformity with the results obtained by the coast-voyage in the year 1501, in which Amerigo Vespucci took part.

The fourth chart represents North America, Labrador, Newfoundland under the name Bacalnaos instead of Bacalhaos, and the country of Corte Real as all three separated from one another by straits. In Central America the Peninsula of Yucatan appears, and the chart must therefore have been finished after the year 1517. Honduras with the islands lying before the same, the Isthmus with the Pacific coast, the latter however without nomenclature, and finally the West India Islands. The South American coast, richly furnished with names, extends southerly over the R. Cananea up to C. Santa Maria, comprising a region which was not drawn upon the former sheet, which however in Kunstmann's opinion was discovered already in the year 1501; others say, that Juan de Solis discovered it first. The original of this chart in the Military Conservatory, contains also the Eastern Hemisphere, which is not communicated in this atlas for want of space. Here the Moluccan isles are noted with the addition: "ilhas de maluqua donde vem ho cravo." The fleet which Albuquerque had sent out to open the trade with the Moluccan Islands, first reached them early in the year 1512.

The fifth sheet has been taken from an atlas which consists of seven charts and formerly belonged to the Monastery of Metten but now is preserved in the Royal Library at Munich. One chart of this atlas bears the inscription: *Vesconte de Maiollo civis Janua composuy hanc cartan in Janua*, with the year 1519, which

probably also indicates the time of origin of the other six sheets. Majolo is situated in the papal dominions, and a Jacobus de Majolo condam Vesconti, probably a son of the one mentioned above, presents himself as the author of a chart: "Janua anno Domini 1551 die 19 marsi." The chart taken from this atlas by Kunstmann commences on the American continent with the coast of Honduras, upon which the Rio de Cama Roma (Cape Cameron), and the Bay of Xagoa, both discovered in 1508, are named. Besides these the four great Antilles are noted upon it and a considerable number of smaller islands. The South American continent is also already drawn out up to the Cape of St. Maria and is richly furnished with names.

The following charts belong to a period after Magalhaens's voyage. Sheets six and seven are taken from an atlas of thirteen charts, which is kept in the Library of the University, and which can only have been drawn after the year 1534, as Cuzco is mentioned in it.

The sixth sheet commences at the eastern coast of America with the terra "che descobrio steuen comes," i. e., the country which Estevan Gomez had discovered in 1525. It contains the *terra de lecendiados*, i. e., the coasts of Pennsylvania, Virginia and Carolina, which the Licentiates Lucas Vasquez de Aillon and Matienzo are supposed to have already discovered in 1520; and also Mexico under the name *Temistitan vel Misicho*;—the central American coast, near which Yucatan is represented as an island;—the Antilles and the northern coast of South America. In the south, we perceive Magalhaens's Strait (Strictum de Magellano) with the harbor of St. Julian and Fireland, and from the western coast of America is seen a continuous stretch of Colao Provintia and Peru Provintia in the south, up to California in the north, which latter is represented as a peninsula. In the remoter part of the Pacific Ocean, several of the east Asiatic islands are noted as Dshilolo, Timor, Sumatra, and on the eastern side of Asia, Bengala Civitas and China Civitas.

The seventh sheet, taken from the same atlas, represents the countries on both sides of the Atlantic Ocean: the eastern coast of America from Newfoundland (terra de bacalaos) in the north, to Magalhaens's Strait, inclusive of that part of the Brazilian coast which is wanting on the former chart, and the coast of La Plata south to the Strictum de Magellano and the northern coast of the Fireland with the Campana de Roldan, which is called after a German companion of Magalhaens. As on the former sheet so also here the west coast of Patagonia and the coast of Chile are wanting.

The sheets eight to twelve are taken from the atlas of Vaz Dourado, the original of which with the year 1571 is found in the Archives at Lisbon. The Royal Library at Munich possesses

a much more splendid copy of the year 1580, which however deviates in many respects from the original. The eighth sheet furnishes a complete drawing of the coast of South America south of the mouth of the La Plata with Magalhaens's Strait, on which the Cape *dellas virgines* and the Fireland, which is divided into several islands, are named. The western coast of South America is abundantly furnished with names. The ninth sheet is equally rich and contains the northern half of South America; the tenth sheet has Central and a part of North America; sheet eleven gives the region where the River St. Lawrence empties into the sea, Newfoundland as an island (a part of its eastern coast appearing as a separate isle) together with the Terra de Lavrador, north of the River St. Lawrence; and finally sheet twelve gives the western coast of North America, including the peninsula and the Gulf of California.

The last sheet of the atlas reproduces an old English chart with the inscription "Thomas Hood made this platte 1592." The original belongs to the valuable collection of the Duke of Northumberland, Robert Dudley, who died 1639 at Florence in Italy. The part of America which is here represented, comprises the great Antilles, the Bahama isles, the coast of Yucatan, Mexico, Florida and Norumbega, which latter name is retained for a considerable part of the American coast south of the River St. Lawrence.

The atlas therefore comprises a great number of most valuable documents in relation to the history of the discovery of the new continent. The execution of the different sheets is so excellent, that the whole work may justly be called splendid. The text accompanying the same, contains, besides Kunstmann's comments above mentioned and the explanatory notes to the single charts, a log-book, first edited by G. M. Thomas, which was taken from a ship of Drake's third expedition (Aug. 28, 1595 until May 10, 1596,) and is preserved in the Royal Library at Munich.

THE FATE OF SIR JOHN FRANKLIN.—The following letter has been addressed to the Secretary of the Admiralty by Capt. F. L. McClintock, R. N.

"Yacht Fox, R. Y. S.

"Sir: I beg you will inform the Lords Commissioners of the Admiralty of the safe return to this country of Lady Franklin's Final Searching Expedition, which I have had the honor to conduct.

"Their lordships will rejoice to hear that our endeavors to ascertain the fate of the 'Franklin Expedition' have met with complete success.

"At Point Victory, on the northwest coast of King William's Island, a record has been found, dated the 25th of April, 1848, and signed by Captains Crozier and Fitzjames. By it we were

informed that her Majesty's ships Erebus and Terror were abandoned on the 22d of April, 1848, in the ice, five leagues to the N.N.W., and that the survivors—in all amounting to one hundred and five souls, under the command of Captain Crozier —were proceeding to the Great Fish River. Sir John Franklin had died on the 11th of June, 1847.

"Many deeply interesting relics of our lost countrymen have been picked up on the western shore of King William's Island, and others obtained from the Esquimaux, by whom we were informed that, subsequent to their abandonment, one ship was crushed and sunk by the ice, and the other forced on shore, where she has since been, affording them an almost inexhaustible mine of wealth.

"Being unable to penetrate beyond Bellot Strait, the Fox wintered in Brentford Bay and the search, including the estuary of the Great Fish River and the discovery of eight hundred miles of coast line, by which we have united the explorations of the former searching expeditions to the north and west of our position with those of James Ross, Dease and Simpson, and Rae to the south, has been performed by sledge journeys this spring, conducted by Lieutenant Hobson, R.N., Captain Allen Young and myself.

"As a somewhat detailed report of our proceedings will doubtless be interesting to their lordships, it is herewith enclosed, together with a chart of our discoveries and explorations, and at the earliest opportunity I will present myself at the Admiralty to afford further information, and lay before their lordships the record found at Port Victory." D. C. G.

Yale College Library, Oct., 1859.

ART. XLV.—*Correspondence of Prof. Jerome Nicklès, dated Nancy, August 20th*, 1859.

Necrology.—Cagniard de Latour.—This physicist died lately in his 82d year. He was born in Paris, March 31st, 1777. He entered the Polytechnic School in 1794—the year of its foundation. Two years later he left this school to enter the corps of hydrographic engineers. He soon however quitted this duty to devote himself exclusively to scientific labors. Nevertheless he accepted in 1811 administrative duties in connection with his former profession. He had already made himself known by several practical inventions—among others the adaptation of the Archimedan screw to the purposes of a blowing machine. This apparatus is still known in France by the name of *Cagniardelle*, in honor of the inventor.

In 1814, at the time when France was oppressed by the European coalition—Cagniard de Latour invented a process for polishing cannon powder, which passed immediately into use, with the best results.

About the same time he invented a portable mill for grinding wheat in camp. It weighed only seven pounds, and was employed during the disastrous campaign of the Hundred Days.

In 1818 he devoted himself to gas illumination, and largely aided the general introduction of this important industry into France. It was however in 1819 that he made his most important and beautiful invention, the *Sirene*, by which he was able to determine with accuracy the vibrations of sound. This instrument he employed upon various gases and liquids. He discovered thereby the origin of what is called technically *timbre*, that quality in sound by which instruments are distinguished from each other although sounding in the same pitch and with like intensity.

In 1822 he published his researches upon the effect produced by heat upon bodies under great pressures. He deduced from these researches the fact that a liquid may be converted into a vapor occupying the same or but little more space than the original liquid, a result distinguished by Faraday as "*the law of Cagniard de Latour.*" These experiments led to the discovery of the methods of liquefying gases.

By heating wood with steam under high pressure he obtained a tarry product resembling coal. This experiment has been repeated recently under better conditions and real coal has been thus obtained.

Cagniard de Latour is the author of the physiological theory of fermentation, which refers the chemical phenomena to the vital power of a confervoid plant. The dial-faced balance: a machine for estimating the flight of birds: the filiform hydraulic pump and the "canon-pompe," are also his inventions. Moreover he is the author of published researches on the change of volume in bodies submitted to different degrees of tension (traction). Lastly, in 1826 he constructed the Suspended Aqueduct of Crouzol, nearly two hundred meters long, and without intermediate support.

Disinfection and dressing of wounds.—For several weeks the scientific and medical world has been greatly interested by the introduction of a new and remarkable topical application for dressing wounds. Official experiments on this dressing have been made at "*la Charité*," where cancers and other affections of that kind receive special attention. The distinguished surgeon Velpeau, after experiments with this disinfectant on suppurating wounds in a putrid state, has reported favorably to the Academy of Sciences. We extract some passages from his report.

"A large mammillary ulcer with mortification of the skin was treated with the topic both in powder and in pomade. The suppuration diminished and the odor disappeared. At the same time the affected surface became cleansed and the mamma without pain.

In the case of a woman with a vast cancerous ulcer eating away all the left side of the chest, the odor of purulent pus after two daily applications disappeared.

A young man was treated whose hand was scalded by a steam boiler and mortification had supervened, involving nearly the whole of one finger. On Saturday morning this finger was in a complete state of mortification and gave out a disgusting odor, it was dressed on the morning and evening of that day with the powder in question; the bad finger was dried up immediately, the odor disappeared, and the mortification ceased.

Thus in wounds as well as on fetid animal matters disconnected with the body this topic disinfects them at once, having no trace of odor beyond a slight and not disagreeable smell of bitumen.

He adds that this mode of disinfection occasions neither pain, irritation, swelling or inflammation; it also appears rather to favor than otherwise, the progress of granulation and cicitrization; there is therefore no inconvenience in applying it to various ulcers, sores and wounds requiring to be disinfected."

Results equally favorable have been obtained at the veterinary establishment at Alfort.

The Major General of the French army in Italy, anticipating these reported results gave orders for the use of this topic immediately for the relief of the wounded. The success of this treatment has been communicated by Marshall Vaillant to the Academy. The report details the successful treatment by this means of gangrened sores upon twenty wounded Austrians in the hospital at Milan. These cases the physicians assert were of the worst possible character, and the success immediate and complete.

What is this remarkable topic? *It is a mixture of* 100 *parts of plaster of Paris with* 3 *parts of coal tar.* The mixture is easily made in a morter. Its application is made by mixing the powder with olive oil. The application either of the powder or the pomade occasions no distress even if placed in direct contact with the surface. The treatment has the double advantage of disinfecting and also absorbing the pus—thus dispensing with the employment of lint—as the late experience in Italy has abundantly proved.

This simple mixture was originally prepared for the disinfection of artificial manures. Its author is Mr. Ed. Corne, veterinary surgeon at Libos (Lot and Garonne). Mr. Demeaux, one of his medical friends, conceived the idea of applying it to the disinfection of sores, of purulent liquids and the debris of anatomical dissections. Human ordure in full decomposition and giving off an infectious odor has by this powder been instantly transformed into a odorless earthy mass.

The communication of Dr. Velpeau gave rise to an important discussion which we will now consider. M. Bussy at once recalled the fact that charcoal powder, the Boghead coke, creosote and alkaline hypochiorites have for a long time been used as disinfectants. M. Chevreul next called attention to the fact that in the last century Dr. George Berkeley, Bishop of Cloyne, had published a work on the virtues of tar-water, in which he speaks of this agent with enthusiasm. It was esteemed by him as a specific also particularly against ulcers, virus and the scurvy.

More than twelve years ago Dr. Herpin of Metz proposed a disinfecting mixture of plaster and carbon. Dumas reminded the Academy that one of its prizes was a few years since awarded to Mr. Sizet, who showed all the metallic salts which could be used with advantage in disinfection—who also added that the properties of these disinfectants were much exalted by the addition of a small proportion of coal tar. These experiments have also been confirmed elsewhere by Mr. Boussingault, without, it is true, a special reference to the treatment of sores and ulcers.

Coal tar has been used in England for disinfecting dead animals for

the uses of rural economy. The use of coal tar has also been advised for the dead on the battle field.

Dumas added that having often sought an explanation of these facts he had found it in the fact illustrated by Schoenbein that the vapor of turpentine when mixed with air produced an abundance of ozone. He thought that the vapor of coal tar oil might equally ozonize the air. In this case the odorous mixtures would be immediately burned by the ozonized oxygen and the putrid odor rapidly destroyed.

If coal tar really produces this action it is necessary, according to Dumas, to distinguish three effects. 1st, the destruction of the infectious vapor or gas by means of ozone arising from coal tar. 2d, the action of the plaster in preventing the production of new infectious gases by the solidification of the liquids present. 3d, the point of arrest set to the development of putrefactive process by any of the products contained in coal tar, and especially the phenic acid which in the smallest traces in the form of phenate of soda secures the preservation of animal matters in free air.

On the odors of perfumes.—On occasion of the discussion which we have just recorded, Mr. Chevreul offered his ideas upon the mode of action of odoriferous substances. This discussion was intended to recall the publications which this distinguished chemist has made during the past thirty years—researches made specially to trace odors to their material causes. He reviews in the following manner the action by which bodies exert their odors when properly mixed with other odoriferous materials. 1st. Bodies themselves odorant disguise the odors of other substances, as a strong light overpowers a feeble one. 2d. Bodies being themselves odoriferous act in the manner of an acid in neutralizing a base. 3d. Solid bodies may act by capillary affinity to absorb odors, as is the case for example with charcoal. 4th. Other bodies act by altering the constitution of the odorant substance, producing new compounds either odorless or nearly so. Such is the action of moist chlorine or oxygenated water. 5th. Lastly, the action may be two-fold, as in the case of chlorine and ammonia, decomposing one portion and neutralizing the other without decomposition.

Neutralization includes the largest class of cases; thus the volatile odorous acids are neutralized by alkalies to form odorless salts. Ammonia loses its odor when united to an acid. The odors in such cases are truly neutralized, since displacing the acids liberates again the odors each in its own character. Examples of the destruction of odors are numerous and well known to chemists. Sulphydric acid, for instance, is at once decomposed by chlorine and consequently disinfected. Ammonia by the action of chlorine offers an example of both neutralization and destruction of odors, because at the same time we have decomposition of one part of the base and the neutralization of another part by the chlorohydric acid formed.

M. Chevreul proposes to define odors by means of a scale, analogous to our notation of sounds, or for gradations of color by the chromatic diagram (which last device we also owe to this *savant*). The great obstacle to this plan is the difficulty of employing the sense of smell as we employ that of sight or hearing, a difficulty much increased by the toleration which the smell soon acquires to odors—becoming '*blase.*'

In 1830 he endeavored to take account of the changing odors exhaled by the woad vats during evaporation, if possible to define exactly the kind of odor appropriate to each condition of the vat. He reached no positive results although he detected in the dye stuff bath *five* perfectly distinct odors; the odor of ammonia, a sulphurous odor, a metallic odor, an aromatic odor, clinging for many months to the woolen stuffs which had passed through the woad vat, and lastly, the odor of a volatile acid analogous to that of animal matters in decomposition. M. Chevreul hoped to detect in these odors of the dye vats symptoms to guide the dyer in his art, as the physician finds new indications in his knowledge of symptoms depending on the chemical nature of organic solids and liquids, if these symptoms can be certainly recognized by their odor. Thus he did not shrink from exposing himself to the most repulsive odors of the organism to reach his results. Having often heard the odor of a cancer spoken of as characteristic he examined it and recognized it to a compound of—1st, an ammoniacal odor turning blue a reddened test paper. 2d, a feeble butyric odor. 3d, a heavy odor which is familiar in the 'trying out' of suet or lard. No specific odor exists then in cancers, since the three odors recognized coexist in *non-cancerous* matters which the disease alters. He recognized these matters in the odor of pus and other products of animal origin, and he also detected in them a sulphurous odor and a smell of fish, due probably to a compound ammonia.

To all these odors he adds what he calls the stale-nauseous (*fade nauseabonde*) which appears in well-water that has stood some days in a vessel in which have been placed egg shells impregnated with albumen.

[We may be permitted to add to these interesting facts some others which we submit to the distinguished author of the chromatic circle and researches on the fatty bodies.

1. If an odorous substance can be neutralized or destroyed by another odorant body there are others destitute of odor which by union produce odorant substances.

(To this class of odorless bodies belong O, S, Se, Te, C, H, As, Az, and we might add P, which is oderless unless combined.)

2. Likewise there are odorless bodies which have become odorant by union with others endowed with odor.

It is thus with oxalic, malic, butyric, racemic, citric, sorbic (the acid recently discovered by Hoffmann), boric, silicic acids, all odorless, which however produce with the elements of alcohol, ethers more or less aromatic.

3. It is necessary to distinguish those bodies which act mechanically on the olfactory membranes (e. g., ClH, FlH, BrH, IH, and the vapors of NO_3+HO, SO_3HO) from those which exert a physiological influence (for example, Cl, Br, I, NO_4, SO_2, the hydrocarbons, the essential oils, &c.).

4. It is necessary also to distinguish bodies having an odor proper, that is, an odor which exists when they form compounds with other bodies (for example, arsenic). The arsenical odor is recognized in AsH^3, $AsBr^3$, and in the cacodyl series. Tin is another example. The odor of tin characterizes a large number of stannic compounds. Sulphur: thus SO_2SH, S_2C, SNH_3, SCl, &c., are distinguished by a more or less sulphurous odor.

We might also mention napthaline, benzoin, and other hydrocarbons and organic radicals.

We see that this group of bodies characterized by a peculiar odor, embraces those elements which, like sulphur, arsenic and phosphorus, are destitute of odor, that is, their odor is manifest only in combination. If we examine these phenomena we observe (*a*) that elementary bodies are usually destitute of odor; (*b*) that in general the least odorant compounds are oxygen compounds; (*c*) highly odorant compounds are usually those containing hydrogen. These seemingly singular facts may to a certain extent be explained when we remember that in general chemical compounds become less volatile as they fix oxygen, which by union with hydrogen they become more volatile. But these considerations do not explain all; they do not tell us why CO and CO_2 are odorless gases, while $C_{12}H$, $C_{26}H_8$, $C_{12}H_6$, &c. &c., are odorant.

Moreover the perfumes properly so called, as musk and the aromatic essences, rose, lemon, orange, bergamot, lavender, &c. are eminently hydrogen compounds. They are not all volatile and some of them may be exposed to the air for years, exhaling odor all the time, with no sensible loss of weight. Among these are the perfumes isolated by Milon in 1856.* The cause of odors is not referable exclusively to the phenomena of volatility, although as a general thing the odor of most bodies is developed when they are volatilized.

Hydrogen must be considered, par excellence, the exciting cause of odors. This element possesses above all other substances the peculiar property of developing odors even with odorless bodies, as N, C, Se, Te, P, &c., and a great number of compounds, of these and other elements.

Oxygen on the other hand appears to act the chief part in the perception of odors; it seems indeed proved that odors are not recognizable where there is not oxygen in the air to bathe the olfactory membranes.]

Humboldt Foundation.—[After mentioning this foundation, of which we give a more detailed notice on a subsequent page of this volume, our correspondent adds:—] We remark that this foundation resembles the Society for Aiding the Friends of Science, with this difference, that the Humboldt Foundation proposes particularly to aid rising talent and to encourage scientific explorations, while the Society for the Friends of Science sustains scientific men in declining health and comes to the relief of their widows and orphans. The two organizations are therefore complementary to each other, and are worthy to go on side by side.

Photography by Carbon. Concours for the prize founded by the Duke of Luynes.—We have for some years past discussed this photographic question—the object of a prize established by a distinguished amateur, the Duke of Luynes. It is required to discover a method by the use of carbon alone, neglecting salts of gold, silver, and other metals, to produce photographs, this being the only material which submitted to the test of time has transmitted to us without change records almost 3000 years old. The Concours has been held; but unfortunately the Commission of the Photographic Society, to whom it was referred, are unable to announce a full success and the trial has been adjourned for three years.

* This Journal, July, 1856, p. 109.

Many persons contested the prize. The desideratum is to obtain a coating of carbon in a manner analogous to that from silver or gold, namely, by reduction. But chemistry as yet has failed to discover a process for the reduction of carbon compounds, and photographers have resorted to animal black which they have applied in any convenient manner to plates previously exposed to the sun. We give a *résumé* of the new results in two memoirs esteemed by the Commission worthy of reward.

Messrs. Garnier and Salmon, the authors of one of these memoirs, cover the surface of paper with a film obtained from an intimate mixture of bichromate of ammonia and albumen. This coating is dried by heat and exposed to the sun in a frame covered by a glass positive. The picture appears in a yellow-brown tint which becomes more intense by a gentle warmth. The sheet thus prepared is fixed on a planchette and covered with finely powdered ivory-black, the coating being made even by a stump of cotton. It is next detached and plunged in common water, the image uppermost, and there gently moved at intervals for a quarter of an hour. The water is then drawn off and the picture served in a bath composed of 5 parts of concentrated sulphurous acid diluted in 100 parts of water, moving it about as before at intervals. After this double process the carbon almost entirely disappears from the lights and clear spaces, while it remains in quantities proportional to the greater or less intensity of action of the light upon the other portions, and thus the proof finally reproduces the positive, but not perfectly, since the lights and half tints are not pure and the blacks lack somewhat of brilliancy and perfectness. But the process is simple and good; it remains only to perfect it.

M. Pouncy, another competitor, operates a little differently, but obtains results equally satisfactory. His process differs in applying the carbon before exposure of the proof to light, the sensitive coating being formed at once, of bichromate of potassa, gum arabic and finely divided carbon, exposed not under a positive but under a negative plate. On removal the plate is placed in a bath of pure water; after five or six hours immersion he washes under a cock of common water and the carbon positive is obtained.

In this process the manipulation is a little easier and more simple. The use of a negative authorized the expectation of a better result, but the exposure is longer than in the mode of Garnier and Salmon, whose use of a positive avoids the chances of accident which attend the negative plates in the hands of the operator.

Messrs. Pouncy, Garnier and Salmon share the prize with Mr. Poiterin, who has the merit of anticipating these photographers, whose methods are only an advance on the process which Mr. Poiterin published in 1856.

Transformation of cellulose into sugar.—We have already spoken in this Journal* of the plan of Pelouze for facilitating the experiment of Braconnot—the transformation of cellulose into sugar—by exposing the woody fibre and dilute acid to high pressure and heat. It is known, and the fact is recognized by M. Pelouze himself, that this idea has been some years since put in practice both by Mr. Weil and also by Mr. Tribouillet, who obtained a patent for the process.

* This volume, page 126.

Transformation of cellulose into parchment or parchment-paper.—It appears that this curious product of the action of concentrated sulphuric acid on bibulous paper, by which means the paper is changed to a tissue very much resembling ordinary parchment, nearly as strong and resisting the action of boiling water, which parchment does not. It appears that this is not a new observation, but was first made known in 1846 by Messrs. Poumarède and Figuier in the Journal de Chemie et de Pharm. for 1847, under the name of *papyrine*. This product however was prepared by aid of an acid of less concentration than is used for parchment-paper and consequently it did not possess all the desirable properties belonging to vegetable parchment, which is susceptible of a multitude of important applications.

Acclimation. The Dromedary imported into South America.—On the 21st of June last the ship "*Splendide*" of Marseilles sailed from the port of Algiers for Brazil, having on board fourteen camels (four males and ten females) selected and purchased by the Society for Zoological Acclimation (*Societé Zoologique d'Acclimation*) to the order of the Brazilian government; this government having decided to test the acclimation of these animals in the sandy provinces of Brazil. Several of these provinces, particularly Céara, during many months of the year are destitute of water, and much resemble in physical characters those regions of Africa and Asia where the camel and dromedary are so eminently serviceable.

The Society of Acclimation, in view of the importance of the case, have sent one of the Vice Presidents of the society, M. Richard (du Cantal), a distinguished zootechnist, to Algeria, between Boghar and Lagonat, in a region inhabited by one of the tribes most distinguished for the number and beauty of their dromedaries. From these herds Richard selected ten females of three to four years old, three males of four years, and one of seven, all in the highest condition, at a cost of 380 francs each. Four Arab camel drivers were also obtained to accompany the animals.

The July (1859) number of the Journal of Acclimation relates all the history of this experiment, to which we refer for the details. But it is to be remarked as regards the prospect of success for this enterprize that a similar experiment has met with success some time since in Texas and Central America, the credit of which is due to Major Wayne of the United States Army.

Bibliography.—There has appeared from the central book depot of Agriculture at Paris

Dictionnaire raisonné d'Agriculture et d'Economie du Bétail par le Dr. Richard, du Cantal, 2 vol. in 8vo.—Richard is one of the Vice Presidents of the Society for acclimation spoken of above. He is best known for his intimate knowledge concerning domestic animals and especially of what in France is called *Zootechny*. The two volumes of his Dictionary are filled with his observations on this important agricultural question.

Mallet-Bachelier, quai des Augustines, Paris, has published—

Recherches sur les Météores et sur les lois qui les régissent par Coulvier Gravier. 1 vol. in 8vo, with numerous plates.—Mr. Coulvier Gravier has brought out in this volume the fruit of forty years of observations on the state of the heavens. We have often found occasion to mention his ob-

servations on shooting stars. This work embraces all belonging to what are called *meteors*. The author is under great obligations to the French government who, on the recommendation of Arago, placed Mr. Coulvier Gravier in a situation to follow his tastes for this sort of observation. This observer does not despair of obtaining the means of predicting the meteoric *periods*. He unfolds his theory in a volume which all can understand, since it is written in a simple style and contains few mathematical formulæ. It shows that the author has obeyed a controlling taste; and his work fills an important gap in astronomical bibliography.

Cours de Mecanique appliqueé par M. Mahistre. 1 vol. 8vo, illustré de 211 figures.—Mr. Mahistre is professor of Mechanics *a la Faculté des Sciences a Lille*, one of the great manufacturing centers of Europe. His admirable work is especially adapted to engineers and to students who are destined to industrial pursuits.

Cours de Mécanique appliquée par M. Bresse. T. 1.—Mr. Bresse is Professor of Mechanics at the celebrated *Ecole des Ponts et Chaussées*. This first volume treats specially of the strength of materials. Like the work of Mahistre, it is particularly adapted to civil engineers; above all it interests the engineers of bridges and roads, who in France occupy so important a rôle, particularly in railroad constructions. Multitudes of these engineers are found scattered over the continent of Europe, especially in Russia, Germany, Spain, Switzerland and Belgium. The science of the pupil gives evidence of the master, who is Mr. Bresse.

Cours d'Electrophysiologie par M. Matteucci. 1 vol. 8vo.—This course pronounced at the University of Pisa is now reproduced in France where the well known high reputation of the author will secure it the attention it deserves.

Cours d'Analyse de l'Ecole Polytechnique par M. Sturm. T. II, in 8vo, 1859.—We have already announced the first volume of this great mathematician, who died some years ago. It is published by one of his pupils, Mr. Proutret, by the choice of the author, and from the manuscript left by him. This work is of special value to professional mathematicians, and to those who are charged with the instruction of this science.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On Torsion and its relations to Magnetism.*—WIEDEMANN has communicated several interesting papers on torsion and its relations to magnetism, from the last of which we extract the following comparative view, referring to the original paper for the details of the experimental methods employed.

Torsion.	*Magnetism.*
1. The temporary torsions of a wire twisted for the first time by increasing weights, augment more rapidly than the weights.	1. The temporary magnetisms of a bar magnetized for the first time by increasing galvanic currents, augment more rapidly than the intensities of these currents.

2. The permanent torsions of the wire increase still more rapidly.

3. A much smaller force is necessary to untwist the wire than to twist it.

4. By repeated turnings of the wire, its torsions approximate more and more closely to a proportionality with the turning weights. The torsions are thereby greater than in the first turning.

5. By repeated application of the same twisting and untwisting weights, G. and −G. the maximum of torsion reached in the turning, sinks, and the minimum reached in the detorsion of the same, rises up to a definite limit.

6. When twisted beyond the limits of the repeated torsions and detorsions the wire behaves as if it were twisted for the first time.

7. A twisted wire which is untwisted by the force −G cannot be twisted by repeated action of the force −G in a direction opposite to the first torsion. But the force +G twists it easily in the first direction.

8. When a wire which possesses the permanent twisting A is brought by the force *b* to the torsion B and then farther to the torsion C, which lies between A and B we need the force *b* to give it again the torsion B. In this case, A may be also 0, and B may be greater or smaller than A.

9. Vibrations during the action of a twisting weight increase the torsion of a wire.

10. The permanent torsion of the wire after removing the twisting weight, is on the contrary, diminished by vibrations.

2. The permanent magnetisms of the rod increase still more rapidly.

3. A much weaker counter current is necessary to demagnetize the bar, than to magnetize it.

4. In a case of repeated magnetizations of the bar, its magnetisms approach more and more closely to a proportionality with the intensity of the magnetizing currents. The magnetisms are thereby greater than in the first magnetization.

5. By repeated application of the same magnetizing and demagnetizing currents, J. and −J. the maximum of magnetism reached in the magnetization, sinks, and the minimum of the same reached in the demagnetization rises up to a certain limit.

6. When magnetized beyond the limits of the repeated magnetizations and demagnetizations, the bar behaves as if it were magnetized for the first time.

7. A magnetized bar which is demagnetized by a current of the intensity −J cannot be magnetized in a direction contrary to that of the first magnetization by repeated action of the current −J. But the current +J magnetizes it easily in the first direction.

8. When a bar which has the permanent magnetism A is brought by the current *b* to the magnetism B, and then farther to the magnetism C, which lies between A and B, we need the current *b* a second time in order to communicate again the magnetism B. In this case A may also be 0, and B may be greater or smaller than A.

9. Vibrations during the action of a magnetizing current, increase the magnetism of a bar.

10. The permanent magnetism of the bar after removing the magnetizing current is on the contrary, diminished by vibrations.

11. A wire twisted and then untwisted loses or gains torsion by vibration according to the magnitude of the detorsion.

12. The permanent torsion of iron wires diminishes by their magnetization, and that in a ratio which diminishes as the magnetism increases.

13. Repeated magnetizations in the same direction scarcely diminish the torsion of the wire. A magnetization in the opposite direction to the first produces however a new strong diminution of the torsion.

14. When a wire, by frequent magnetizations in opposite directions, is untwisted as far as possible by this process, it assumes by magnetization in one direction a maximum, by magnetization in the opposite direction a minimum of torsion.

15. A twisted wire which has been partially untwisted, loses by magnetization much less of its twist than an ordinary twisted wire. A wire farther untwisted, exhibits on feeble magnetization at first an increase of its torsion, which by augmenting the magnetization rises to a maximum and then again diminishes. The more strongly the wire was untwisted, the stronger must the magnetism be, in order to reach this maximum. When the wire is very strongly untwisted, its torsion increases, even up to the application of the strongest magnetization.

16. When a wire is magnetized while under the influence of the twisting weight, its torsion increases by weaker, diminishes by stronger magnetization.

17. A wire twisted at the ordinary temperature loses torsion by heating, and on cooling again recovers a portion of its loss. The changes increase with increasing torsion. After repeated changes of

11. A magnetised and then demagnetized bar loses or gains magnetism by vibration, according to the magnitude of the demagnetization.

12. The permanent magnetism of steel bars diminishes by their torsion and that in a ratio which diminishes as the torsion increases.

13. Repeated torsions in the same direction diminish the magnetism of a steel bar but little. A torsion in a direction opposite to the first, produces, however, a new strong diminution of the magnetism.

14. When a bar by repeated twisting and untwisting is demagnetized as far as this is possible by torsion within definite limits, it assumes a maximum of magnetism by torsion in one, and minimum by torsion in the opposite direction.

15. A magnetized bar which has been partially demagnetized, loses by torsion much less magnetism than an ordinary magnetized bar. A bar, which has been farther demagnetized, exhibits on feeble torsion, at first, an increase of magnetism which on increasing the torsion, rises to a maximum and then again diminishes. The more strongly the bar was demagnetized, the stronger must be the torsion to reach this maximum. When the bar is very strongly demagnetized the magnetization increases even up to the application of very strong torsions.

16. When a steel bar is twisted when under the influence of a magnetizing current, its magnetism increases by weaker, diminishes by stronger torsion.

17. A bar magnetized at the ordinary temperature, loses magnetism by heating, and on cooling recovers a portion of its loss. The changes are proportional to the magnetization. After repeated changes of

temperature, the wire arrives at a constant state, in which to every temperature corresponds a definite torsion of the wire, which diminishes as this temperature increases.

18. A wire twisted at the ordinary temperature, and then partially untwisted, loses on heating so much the less of its torsion, the farther it has been untwisted. Upon cooling, its torsion is less than before if the detorsion has been slight, but greater if this has been considerable.

19. A wire twisted at a higher temperature, loses torsion on cooling. Upon a second heating, it again loses, and upon a second cooling first regains a portion of its loss. When the wire is vibrated previous to the first cooling, it immediately gains in torsion.

temperature, the bar arrives at a constant state, in which to every temperature corresponds a definite magnetism of the bar, which diminishes as the temperature increases.

18. A bar magnetized at the ordinary temperature, and then partially demagnetized, loses by heating so much the less of its magnetism the farther it has been demagnetized. On cooling, its magnetism is less than before when the demagnetization has been slight, but greater when this has been considerable.

19. A bar magnetized at a higher temperature loses magnetism on cooling. By a secong heating it again loses, and by a second cooling first regains a portion of its loss. If the bar is vibrated previous to the first cooling, it immediately gains in magnetism.

From this comparison it will be seen that there is an analogy between the phenomena of magnetism and those of torsion, which holds good even in the details. The author remarks that this result is incompatible with the old assumption of the existence of magnetic fluids, but that we cannot justly infer from it, that the magnetism of a bar depends upon torsion. This is not proved by experiment; moreover as he proposes to show in another memoir, similar relations are found in the case of other molecular displacements, as for example, in flexion.—*Pogg. Ann.*, cvi, p. 161.

2. *On the densities of vapors at high temperatures.*—H. Sainte Claire Deville and Troost have continued their investigations on the densities of vapors, employing the apparatus already described, but substituting the vapor of boiling cadmium (860° C.) or of zinc (1040° C.) for the vapors of mercury and sulphur, used in their former experiments. The vessels employed were of porcelain, instead of glass, and could be hermetically sealed by means of the compound blowpipe. To avoid the difficulties of a precise determination of the temperature, the authors always employed vessels of the same substance and of the same capacity, in which they enclosed successively vapor of iodine and the vapor of the body experimented upon. In this manner, the ratio of the densities of the two vapors was determined—the density of the vapor of iodine having been previously accurately determined. By this process the determination of the temperature becomes unnecessary. The authors results were as follows:

Sulphur, at the temperature of 860° has a vapor density of 2·2, and this density does not change as the temperature rises, being the same at 1040° as determined by more than twelve experiments. We may there-

fore admit with certainty that the equivalent of sulphur (16) represents one volume of vapor, like oxygen (8).

The vapor of selenium presents the same anomalies as the vapor of sulphur. At 860° its density is 8·2; at 1040° it is not more than 6·37. The authors propose to determine the density of this substance at still higher temperatures.

The vapor density of phosphorus at 1040° is 4·5=1 vol., corresponding to the equivalent generally adopted. The vapor density of cadmium at 1040° is 3·94=2 vols. Calculated on this hypothesis it would be 3·87.

At 1040° the vapor density of sal-ammoniac is 1·01=8 vols. (calculated =0·92.) The observed vapor density of bromid of aluminum is 18·62=2 vols. (calculated =18·51).

The vapor density of iodid of aluminum in like manner corresponds to 2 vols., and is 27·0 by observation; 27·8 by calculation.

These two last numbers are calculated from experiments made in the vapor of sulphur. The iodid of aluminum exhibits a singular property indicating that its elements are united by a very feeble affinity. This iodid fuses at 125°, boils at 350°. At this temperature its vapor behaves as if it were composed of pure aluminum in a peculiar state of insulation; it burns in the air on contact with an ignited body, giving iodine and aluminum. It explodes by the electric spark when mixed with oxygen, in a strong vessel.—*Comptes Rendus*, xlix, p. 239.

3. *On organic compounds which contain metals.*—Frankland has published a fourth memoir in continuation of his investigations of the compounds of metals with organic radicals. By the action of zinc-ethyl upon the iodid of stannethyl, the author obtained a crystalline compound of iodid of zinc and bi-ethyl-tin, having the formula $Sn(C_4H_5)2+ZnI$, the reaction being represented by the equation

$$SnC_4H_5I + ZnC_4H_5 = (Sn(C_4H_5)2+ZnI).$$

When this compound is distilled, the distillate washed with water and again distilled, bi-ethyl-tin passes over as a clear colorless liquid, of a faint ethereal smell, and a somewhat metallic but not disagreeable taste. The density of its vapor is 8·021, which corresponds to 1 vol. of tin-vapor and 4 vols. of ethyl, the 5 being condensed to 2. It boils at 181° C. and distils over unchanged. It burns with a dark deep blue bordered flame giving off white vapors of oxyd of tin. Bi-ethyl-tin like zinc-ethyl is not capable of uniting with any other element unless an equivalent of ethyl is separated at the same time. Iodine forms with it a compound having perhaps the formula $Sn_2(C_4H_5)2I$, though it may be the compound described by Cahours and Riche, $Sn_2(C_4H_5)3I$.

By the action of methyl-zinc upon iodid of stannethyl, Frankland obtained a colorless liquid having the formula $Sn\left\{\begin{matrix}C_4H_5\\C_2H_3\end{matrix}\right.$ which he terms ethylo-methylide of tin, the vapor density of which also corresponds to 2 vols.

When zinc-ethyl is brought into contact with the iodid of methyl-mercury, $Hg\left\{\begin{matrix}C_2H_3\\I\end{matrix}\right.$, iodid of zinc is separated after a few hours, and on distillation, bi-ethyl-mercury is obtained. This body agrees completely with

the ethylide of mercury described by Buckton. Its formation may be represented by the equation

$$Hg(C_2H_3)I + 2Zn(C_4H_5) = Hg(C_4H_5)2 + Zn(C_2H_3) + ZnI.$$

This result exhibits a mobility in the atomic groups of these compounds which could scarcely have been expected.

By the action of zinc-methyl upon the chlorid of mercur-ethyl and subsequent distillation, the author obtained only a mixture of ethylide of mercury, $Hg(C_4H_5)2$, and methylide of mercury, $Hg(C_2H_3)2$, but considers it probable that in the above reaction an ethylomethylide of mercury is actually formed, but that this is subsequently decomposed by distillation.

In a previous memoir, the author showed that the vapor density of zinc-ethyl requires the formula $Zn_2 \left\{ \begin{matrix} C_4H_5 \\ C_4H_5 \end{matrix} \right.$; nevertheless it was not found possible to produce the intermediate compound, $Zn_2 \left\{ \begin{matrix} C_4H_5 \\ C_2H_3 \end{matrix} \right.$

Frankland did not succeed in preparing zinc-methyl by the action of iodid of methyl upon zinc in a copper digester, although the process usually succeeds in small glass tubes. When a solution of iodid of methyl in ether is treated with zinc in the copper digester, zinc-methyl is formed in large quantity, but on distillation a body is obtained which has the formula $2Zn_2 \left\{ \begin{matrix} C_2H_3 \\ C_2H_3 \end{matrix} + \begin{matrix} C_4H_5 \\ C_4H_5 \end{matrix} \right\} O_2$, and which therefore appears to be a definite compound of zinc-methyl and ether. The vapor density of this liquid is 3·1215, which corresponds to 2 vols. of the vapor of zinc-methyl and 1 vol. of the vapor of ether united *without* condensation. As this result is *à priori* improbable, Frankland remarks that a mixture of zinc-methyl vapor and ether vapor in the above proportions would have the density 3·0413, without however definitely adopting either view.—*Ann. der Chemie und Pharmacie*, cxi, 44.

4. *On the isomorphism of stannic, silicic, and zirconic acids.*—The observation of Marignac that the fluostannates and fluosilicates are isomorphous, renders it necessary to assume that silicic acid, like stannic acid, contains two equivalents of oxygen. G. Rose directs attention to the fact that zircon has the same crystalline form as tinstone, and agrees with this also in the cleavages. The isomorphism of zircon with one of the forms of titanic acid is still more close, although zircon has not like rutile and tinstone been found in twin crystals. The author remarks that zircon must be regarded as an isomorphous combination of one atom of zirconic and one atom of silicic acids. It appears however that there are some varieties of zircon in which the two acids are united in other ratios. Hermann has examined a zircon containing two atoms of zirconic and three of silicic acids, and has named the mineral Auerbachite; it has the same crystalline form as ordinary zircon.—*Ann. der Physik und Chemie*, cvii, 602.

5. *On the equivalent of manganese.*—The equivalent of manganese was determined by Berzelius as 27·56, from two analyses of the chlorid. Von Hauer has recently found for this equivalent the number 27·5 by reducing anhydrous sulphate of manganese by sulphuretted hydrogen to sulphid of manganese. His result, 27·5, was the mean of nine experi-

ments. Dumas, in his well known memoir on the equivalents of the elements, asserted that he had determined the equivalent of manganese by reducing an artificial peroxyd to protoxyd by means of a current of hydrogen, and that he had found the number 26, as he expresses it, *d'une manière absolue.* In a later communication, however, he gives the number 27·5 as the true equivalent of manganese, the same being determined by the method of Berzelius. Schneider objects to the methods of Berzelius and of von Hauer, believing that both are subject to constant sources of error. He has therefore determined the equivalent anew by the method already employed by him with cobalt and nickel, viz., by the analysis of pure neutral oxalate of manganese, the ratio between the carbon and manganese being sufficient for the purpose. In this manner four experiments closely agreeing with each other gave as the equivalent of manganese 27·019, or in round numbers 27. This result is further confirmed by the experiments of Rawack made in Schneider's laboratory, by reducing the oxyd of manganese, Mn_3O_4, in a current of dry hydrogen to protoxyd. Six experiments gave as a mean, 27·009 for the equivalent. —*Pogg. Ann.*, cvii, 605.

6. *On the equivalent of nickel.*—Schneider has furthermore revised his experiments on the equivalent of nickel, in consequence of the objection of Marignac, that the oxalate of nickel employed in his former determinations may have contained free oxalic acid. Three experiments, in which the ratio of the nickel to the carbon was determined, led as before to the equivalent 29, neglecting decimals in the second and third places.

In a third paper on equivalents and on the determination of equivalents in general, Schneider has given a very severe, but at the same time, very just criticism of Dumas' two memoirs on the atomic weights of the elements.

7. *On an easy mode of preparing metallic chromium.*—Wöhler has given a very simple method of preparing metallic chromium by the action of zinc upon the violet chlorid. The process is as follows: one part of chlorid of chromium is mixed with two parts of chlorid of potassium and sodium, the mixture introduced into a common crucible packed tight, two parts of granulated zinc laid upon it, and covered with a layer of alkaline salt. The crucible is then heated till the mass fuses. When on removing the cover for an instant, a zinc flame is observed, accompanied by a peculiar sound, the heat is diminished by closing the draught, and the mass kept about ten minutes in fusion. The crucible is then to be removed from the fire, gently struck to collect the metal, and allowed to cool. On breaking the crucible, a well fused regulus of zinc is found under a green slag. After being well cleaned in water, it is to be placed in dilute nitric acid, which is to be frequently renewed till all the zinc is dissolved. The chromium remains as a crystalline powder, which is again to be heated with nitric acid and then well washed.

As thus prepared, chromium is a bright gray, highly crystalline powder. Under the microscope, the crystals are distinctly seen to be very sharp rhombohedrons of great lustre and almost tin-white color. Its specific gravity is 6·81 at 25° C.; it is not magnetic. Heated in the air, it oxydizes, becoming yellow and blue like steel, and gradually becomes covered with a thin layer of green oxyd. When heated in chlorine, it

glows vividly and becomes violet chlorid. Chlorhydric acid dissolves it easily to the blue protochlorid. Dilute sulphuric acid which dissolves iron easily is without action upon chromium; but on gently warming a very violent action sets in and the remaining metal now acquires the property of being easily dissolved after washing even by the most dilute sulphuric acid. Concentrated and boiling nitric acid does not attack it in the least.—*Annalen der Chemie und Pharmacie*, B. cxi, p. 230.

W. G.

II. BOTANY AND ZOOLOGY.

1. *Two new Genera of Dioœcious Grasses of the United States;* by George Engelmann, M.D. Extr. from the *Transactions of the Academy of Natural Sciences of St. Louis, Missouri*, Vol. I, p. 431–442, with three plates, 8vo. August, 1859.—The *Buffalo-Grass*, so abundant and so widely diffused over the broad, arid region which separates our Pacific from our Atlantic possessions, is one of the humblest plants of its order, rising only a few inches above the surface of the soil; but at the same time it is one of the most important and useful, since it forms the principal subsistence of the Buffalo, for a part of the year, and no less so of the cattle of the emigrant. The botanical history of this little grass, now happily completed by Dr. Engelmann, is remarkable. Nuttall first named and described it, nearly thirty years ago; and, while he referred it to *Sesleria*, suspected it to be *sui generis*, and threw out a happy conjecture as to its natural relationship. Torrey figured it twelve years ago, and also announced its affinity to the *Chlorideæ;* he at the same time discovered its dioœcious character, and showed that only the male plant was known. At length Dr. Engelmann has detected the female plant in a rather rare grass, the *Anthephora axilliflora* of Steudel, which is so unlike the common Buffalo-Grass that it naturally had been referred to a widely different tribe. Struck by the similarity of their foliage and stoloniferous growth, as they occurred together in a collection made by his brother, Dr. Engelmann shrewdly suspected the relationship, and finally set the question at rest by finding a male Buffalo-Grass which happened to bear a stalk of female flowers from the same rootstock; and these flowers were those of the so-called *Anthephora*. So different are the two that nothing short of this ocular proof would have been convincing. It hardly need be said that the male plant is not a *Sesleria*, nor the female an *Anthephora;* although they severally resemble these genera, or at least the female spikelets have a very great external resemblance to the Paniceous genus *Anthephora*. So that, Dr. Engelmann, having to characterize this new generic type, very naturally named it *Búchloë*, (as shorter and more euphonous than *Bubolóchloë*), i. e. Buffalo-Grass; and he retained the specific appellation of *Dactyloides*, although the male plant is not much like a *Dactylis*, and the female wholly unlike. Very glad we are to see the genus established under so appropriate a name,—the more so as it has narrowly escaped a different fate. That is to say, two inchoate attempts seem to have been made to found a genus upon the male sex. First, in Sir William Hooker's enumeration of the plants of Geyer's western collection, we find "*Calanthera dactyloides*, Kth.—Nutt. Sesleria, *Nutt. Gen.* v. i, p. 65." But neither Kunth nor any

other author has described a genus *Calanthera*. We have a suspicion that the "Kth." is a slip of the pen, and that the name is really Nuttall's, given by him to a specimen in the Hookerian herbarium. But if this be so, the manuscript name (which, moreover, is destitute of any particular significance) can by no means now supersede Engelmann's published one; though we might have been constrained by courtesy to adopt it, if this suspicion had occurred to him, and he had been able to confirm it. Again, in the corrections at the close of the *Plantæ Hartwegianæ*, Mr. Bentham applies the name of "*Lasiostega humilis*, Rupprecht (ined.)" to No. 250, which he had before called a *Triodia*. The plant is undoubtedly a male Buffalo-Grass. But no genus *Lasiostega* is found to be published, nor has this name any appropriateness as applied to the plant in question.

It is curious to remark that the male plant, being more proliferous by stolons than the female, has nearly displaced the latter, or has (so far as known) attained a wider geographical range as well as a far greater abundance. Probably, in accordance with a general law, the tendency to barrenness from seed which accompanies copious multiplication by offshoots, has also assisted in the production of this result,—a state of things quite contrary to the genius of that polygamous community which has effected a lodgement in the region of Buffalo-Grass.

Dr. Engelmann's second genus, *Monanthochloë*, is founded upon a singular, exceedingly stoloniferous, littoral grass, with leaves scarcely half an inch long, with solitary sessile spikelets, which has long been known to occur on the coast of Texas and Florida (collected by Berlandier, Drummond, and Blodgett), but has never been studied until now. In fact it has been thought to be something abnormal, on account of its showing as its most interesting feature, a regular transition from the foliage to the paleæ of the flowers. Dr. Engelmann notes that the glumes are wanting [perhaps represented by ordinary leaves of the axis of which the spikelet is a direct continuation], the uppermost leaf representing the lowest palea of the spikelet. The latter consists of three to five flowers, of which the lowest flower and sometimes the next are neutral or rudimentary, from one to three succeeding ones are staminiferous or pistiliferous, according to the sex, and the uppermost is also reduced to a rudiment. In the hands of agrostologists such a grass as this will be likely further to elucidate the floral structure of the order, the theory of which is by no means settled yet. Dr. Engelmann's three excellent plates, displaying all the details of the flowers, will facilitate this investigation.

The youthful Academy of Natural Sciences of St. Louis is well inaugurating its public career by publications of such character as this paper, and the more elaborate *Monograph of Cuscuta* by the same author, which is now in press. A. G.

2. *Trichomanes radicans*, Swartz.—The discovery of this Fern in Alabama by Mr. Peters and Mr. Beaumont, along with a minute new species, allied to West Indian ones, was announced in this Journal several years ago. More recently Mr. Eaton has detected indications of *T. Petersii* in West Florida, where *T. radicans*, also, will probably yet be found. We have now to state that the Rev. Dr. Curtis has discovered a locality of the latter species, during the past summer, in the Cumberland Mountains, in the eastern part of Tennessee, under the ledge of a dripping rock. Con-

trary to what would have been expected of the habitat of such a Fern, the district is very far from humid, as may be inferred from the paucity of fleshy Fungi. A. G.

3. *Thesaurus Capensis: or Illustrations of the South African Flora, being Figures and brief Descriptions of South African Plants, selected from the Dublin University Herbarium;* by Wm. H. Harvey, M.D., F.R.S., &c., Prof. Bot. Univ. Dublin, &c. Dublin, vol. I, No. 1, 1859.—The Nos. contain 25 plates each: the present one is accompanied by 16 pages of letter-press, all in octavo. The work is designed to be a running supplement and iconography of the Flora Capensis, now in preparation by its author in connexion with Dr. Sonder. It is published in quarterly parts (at 5 shillings sterling each), four to a volume of one hundred plates, with descriptions. The author is pledged to finish the first volume, and intends to continue it through five or six volumes, if encouraged by the sale of the first. As "the impression is limited to 250 copies, 150 of which are reserved for colonial sale," we cannot doubt that Prof. Harvey's moderate expectations in this respect will be satisfied. A few copies should be secured in this country,—for which Prof. Gray of Cambridge will receive subscriptions. The *profits* of the sale, *if any*, are to be devoted to the University herbarium, of which the author is the curator. The plates are very good for general habit and appearance, but the lithographic printer has not done full justice to the author's drawings on the stone. The analyses are doubtless very correct. We venture to suggest, however, that they do not always tell all that could be desired, nor does the letter-press supply the deficiency in such cases. For example take the three *Rubiaceæ* illustrated. It is not made to appear that the placentæ of the *Gardenia* are parietal, nor is the insertion of the ovules in the *Kraussia* and *Mitrastigma* made known, nor is any character mentioned to distinguish the latter from *Canthium*, to which it has been referred. A. G.

4. *Grisebach's Outlines of Systematic Botany, for Academical Instruction* (*Grundriss der Systematischen Botanik, &c.;* von A. Grisebach) Göttingen, 1854, pp. 180, 8vo.—A convenient manual for the class-room, and well devised for that purpose. In the classification the arrangement of the orders and the higher groups follows a new and somewhat peculiar fashion. Like all such attempts, it is happy in some associations, and very much open to criticism in others. It is enough to say that, evidently, the scientific grounds of an arrangement of the orders according to nature have not yet been discovered and applied; until they are discovered all our endeavors at shaping forth the system of nature are merely tentative; and the most that can be said of the best of them is, that it is less faulty than others. A feature in this little work which is original, so far as we know (although something much like it has been devised by Dr. Pickering), and well worthy of adoption, is the neat formula for expressing the numerical plan of the flower in an order or genus, &c., and also the degree of union or consolidation. Thus, the type of *Caryophyllaceæ* is expressed by the formula, 5, 5, 10, $\widehat{3}$. These numbers represent the number of parts in the several floral organs, beginning at the left with the sepals; the second figure represents the petals; the next the stamens; the last the pistil. The curved line over the latter indicates

the union of the three carpels into a compound pistil. Take now for example, a few of the genera:

Silene, $\widehat{5}$, 5, 10, $\widehat{3}$. *Dianthus*, $\widehat{5}$, 5, 10, $\widehat{2}$.

Cerastium, $\widehat{5}$, 5, 10, $\widehat{5}$. *Sagina*, $\widehat{4}$–$\widehat{5}$, 4–5, 4–5—8–10, $\widehat{4}$–$\widehat{5}$.

Corrigida, $\widehat{5}$, 5, 5, $\widehat{3}$. *Scleranthus*, $\widehat{5}$, 0, 10, $\widehat{2}$.

The 0 expresses the absence of that part of a complete flower. While the curved line above indicates *connation*, or union of the several parts of a whorl, the bracketed lines underneath express *adnation*, the union of the parts of successive cycles. The character ∞ stands for an indefinite number, as used by DeCandolle. So the formula for *Malvaceæ* is $\widehat{5}$, 5, $\widehat{\infty}$, $\widehat{\infty}$.

For *Hypericineæ*, $\widehat{5}$, 5, $3\widehat{\infty}$ —$5\widehat{\infty}$, $\widehat{5}$. *Rosaceæ*, $\widehat{5}$, 5, ∞, ∞.

Commelynaceæ, 3, 3, 6, $\widehat{3}$. *Irideæ*, 3, 3, 3, $\widehat{3}$.

Gentianeæ, $\widehat{5}$, $\widehat{5}$, 5, $\widehat{2}$. *Scrophularineæ*, $\widehat{2:3}$, $\widehat{3-2}$, 2 : 2, $\widehat{2}$.

Rubiaceæ, $\widehat{5}$, $\widehat{5}$, 5, $\widehat{2}$.

The botanist will perceive the whole plan at a glance. It is equally applicable to the genera; a word or two in addition expressing the nature of the fruit, or any peculiarity of structure. A. G.

5. *Structure and growth of Rootlets.*—According to the Gardener's Chronicle, Prof. Henfrey has published an interesting paper, in the Journal of the Royal Agricultural Society, on the structure of roots. The points which are spoken of as novel and practically important are—1, that "the growing point of a root is not at its absolute extremity, which is covered by a cap-shaped or hood-like portion of epidermis of its own, continuous likewise behind with the cambial structure. This cap-like sheath of the point of the root may be compared with the head of an arrow, forming a firm body, which can be pushed forward by the growing force behind to penetrate through the resisting soil . . . . When it undergoes decomposition in proportion as it is renewed behind, it presents an irregular ragged appearance, which probably gave rise to the idea of a spongy structure at the ends of the rootlets:" i. e. the spongioles of DeCandolle. 2. That in *many* cases there are present upon the young root infinite multitudes of little hairs, through which food is imbibed, and by which the absorbing power of the surface of the root "is considerably augmented." However it may be in England, these are both matters of elementary knowledge in the United States, and have been for the past ten years.—In the Annales des Sciences Naturelles for 1858, published in 1859, Garreau and Brauwers have an article upon the same subject, bringing out essentially the same familiar facts. They, however, direct attention principally to the continued exfoliation of these root-points, by which, in some cases, considerable organic matter is thrown off into the soil,—offering an explanation of the excretion from the roots, of which much account was formerly taken by Marcet and DeCandolle.

Since the above was written we have learned with sorrow the death of *Professor Henfrey*. In the announcement, the editor of the Gardener's Chronicle appropriately remarks, that "Professor Henfrey has long been known as an excellent histologist and sound vegetable physiologist. Especially conversant with the botanical literature of the Germans, it has been to his pen that we owe many valuable dissertations upon subjects little attended to in England. The papers in the Micrographic Dictionary of his friend, Dr. Griffith, are justly celebrated for their accuracy as well as skillful condensation. The physiological part of his Elementary Course of Botany, and the papers on Vegetable Structure now in course of publication in the Journal of the Royal Agricultural Society will always be regarded as the productions of one who was not only familiar with the truths of science, but able to render them attractive to those who are little accustomed to think upon such subjects." Probably his best original contribution to science was his investigation into the formation of the embryo in *Santalum*. A. G.

6. *Some plants take arsenic with impunity.*—That vegetables are killed by watering with an aqueous solution of arsenic was long ago shown by Marcet, Jäger, Link, &c., and also by experiments made in this vicinity within the present year. Still, moulds will grow in paste poisoned with arsenic, and some insects will feed upon animal matter impregnated with arsenic without apparent injury.* Notwithstanding these known exceptional cases, however, the following statements, condensed from the Gardener's Chronicle for Sept. 10, are startling, not only in a physiological point of view, but because, if confirmed, they must affect all medico-legal evidence in cases of suspected poisoning. Dr. Edmund Davy, Professor of Agriculture and Agricultural Chemistry in the Royal Dublin Society, knowing that sulphuric acid containing arsenic was largely employed in making superphosphate and other artificial manures, and that these must therefore contain variable quantities of that substance, conceived it probable that plants supplied with such manures might imbibe some arsenic, and in this way be rendered more or less unwholesome as articles of food. To ascertain, in the first instance, whether plants really take up arsenic when presented to their roots in the soil, Dr. Davy transplanted into a flower-pot three small plants of peas, and when they were established, he commenced watering them every second or third day with a saturated aqueous solution of arsenious acid; and *this treatment was continued for more than a week without its appearing to produce any injurious effects upon the plants.* At this period Dr. Davy was obliged to leave home for some months; on his return he found that these plants had grown up to their full size, had flowered and fruited. On chemical examination he detected arsenic in them, both in the herbage and the seeds. Having thus learned "that arsenic might be taken up in considerable quantity by plants without destroying their vitality, or appearing even to interfere with their proper functions," Dr. Davy proceeded to ascertain whether arsenic as it existed in different artificial manures (such as the superphosphate) would in like manner be taken up by plants growing where these manures had been applied. He tried the experiments with cabbage-plants in a soil consisting of one part of superphosphate to four of garden mould. When a plant had *grown healthily in this soil for three*

* See this vol., p. 166.

weeks (where, the wonder is, that it should have grown at all, irrespective of the arsenic), he cut off its top, tested it for arsenic, and found "the most distinct indications of the presence of that substance." Finally, to ascertain if arsenic could be detected in crops grown with superphosphate in the ordinary way and amount, he took turnips from fields in which this manure had been used, and obtained from them "the most unmistakeable evidence of having been arseniated." The facts thus collected appear to Dr. Davy "to have some important bearings; for though the quantity of arsenic which occurs in such manures is not large when compared with their other constituents, and the proportion of that substance which is thus added to the soil must be small, still plants may during their growth, as in the case of alkaline and earthy salts, take up a considerable quantity of this substance, though its proportion in the soil may be very small. Further, as arsenic is well known to be an accumulative poison, by the continued use of vegetables containing even a minute proportion of arsenic, that substance may collect in the system till its amount may exercise an injurious effect on the health of men and animals." Dr. Davy's paper is published in the London, Dublin, and Edinburgh Philosophical Magazine, Aug. 1859, p. 108. A. G.

7. *Death of Mr. Nuttall.*—We learn that this veteran naturalist,—whose health has for several years been much impaired,—died on the 10th of September last, at his residence, Nutgrove, near Preston in Lancashire, at the age of seventy-three. In view of the great services which Mr. Nuttall has rendered to the botany, ornithology, and mineralogy of the United States during the last forty years, a fitting tribute to his memory may be expected from the hands of some of his surviving friends.

The death of *Dr. Horsefield* is also announced, at the age of 86 years. While Mr. Nuttall, born in England, passed the active portion of his life in the United States, Dr. Horsfield, born in Pennsylvania, made his scientific collections in Java, under the East India Company, in whose service, at the India House, he continued down nearly to the close of his long and honorable life. A. G.

Zoological Notices.—

8. *Bidrag till Spitsbergens Molluskfauna: jemte en allman öfversigt af Artiska Regionens, naturförhallanden och forntida utbredning*, af Otto Torell. Part I, 8vo, pp. 154 and 2 plates. Stockholm, 1859.—A work of much interest to naturalists and others who have directed their researches to the Arctic regions. The first part commences with a historical and geographical account of Spitzbergen, with geological notices, chiefly of glacial phenomena, and a comparison of the fauna of the island with that of neighboring countries for the advancement of our knowledge of geographical distribution. A table is given showing the distribution of 160 species of birds around the Arctic circle. But in this table he makes many species common to the two continents which are not so in reality, as has been recently determined by Baird and Cassin. In the systematic account of the Spitzbergen mollusca this Part reaches only to *Arca* among the bivalves. The synonymy is well elaborated, and the errors of Middendorff and others in that of the *Crenellæ* are exposed.

The following instances will show the opinion of the author with regard to the synonymy of species also found on the New England coast. *Modiola nexa*, Gould, is *Crenella nigra*. *Mytilus levigatus* (*discrepans*

Gould) is *C. substriata* (Gr.). *Nucula tenuis* of Gould is *N. expansa* Reeve, and not the *tenuis* of Europe. *Leda tenuisulcata* of Stimpson is *L. pernula*. *Leda sapotilla* is *L. hyperborea* Lovén (?) One new genus is described, *Dacrydium*, for a shell which is supposed to be the *Modiola vitrea* of Möller. It differs from it in its "dentes crenulati, antico tuberculiformi, postico elongato, cristis suffulti decurrentibus," etc. The occurrence of an *Arca* (*A. glacialis*) in so high a latitude is noteworthy.

W. S.

9. *Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjöbenhavn for Aaret* 1858. With 2 plates. Copenhagen, 1859.—This number contains the following articles:—Plantæ Centroamericanæ; *A. S. Oersted.* Ad Bryologiam Norvegicam annotationes aliquot; *Th. Jensen.* Some remarks on the northern species of the genus *Aega*, and on the proper limits of the genus; *C. Lütken.* On Stegophilus insidiosus, a new fish from Brazil, and on its habits; *J. Reinhardt.* Description of a new species of Serolis, S. Schythei; *C. Lütken.* Annulata Oerstediana, etc.: Enumeration of the Annelides collected by Oersted and Kroyer in the West Indies and Central America; *E. Grube.* Description of the "Gallernosen" at Lolland; *Kostrup.* Supplement to my conspectus of the Danish Echinodermata and to my catalogue of the West Indian and Central American serpent-stars; *C. Lütken.* Winter-flora of Nice; *C. Vaupell.* On the dwelling of the true *Cymothoæ* in the mouths of various fishes; *C. Lütken.* Proceedings of the scientific meetings of the Natural History Society in the year 1858. W. S.

10. *Bidrag till Kännedomen om Skandinaviens Amphipoda Gammaridea af* R. M. Bruzelius. (Kong. Vet. Akad. Handl. 1858.) pp. 104 and 4 plates.—A most valuable contribution to our knowledge of that difficult order the Amphipoda. 77 species are described, of which 18 are new. The new genera are *Lætruatophilus* (fam. Dulichidæ), *Autonoe* (fam. Corophidæ), *Eriopis* (fam. Gammaridæ), *Paramphithoe*, for *Amph. panopla*, *hystrix*, *bicuspis*, etc., (why reject *Amphithonotus* Costa,) and *Nicippe*, near *Pardalisca*. Nineteen species are figured. The descriptions in Swedish are very elaborate, and a Latin character is given for each species. W. S.

III. ASTRONOMY.

1. *Supposed planet between Mercury and the Sun.*—At a session of the French Academy of Sciences, Sept. 12, 1859, a paper by M. LeVerrier was read, giving the result of his researches undertaken in order to ascertain the cause of the discrepancies between the places of Mercury as determined by observation of its transits across the sun and as required by theory. He finds that by adding 38 seconds to the secular motion of the perihelion of Mercury, these observations will be represented within about one second. The cause of this disturbance he presumes to be either one planet or a group of small planets within the orbit of Mercury; and calls on observers to watch the sun's disc in order to detect the transit and also during total solar eclipses to scrutinize the vicinity of the sun.

Note.—In this connection it may be worth while to state that there are already on record observations which make it highly probable that there exists an intra-Mercurial planet with a satellite. Wartmann reports

(*Bibl. Univ.* Avr. 1837, p. 409; *Quetelet: Corr. Math. et Phys.*, Aug. 1837, p. 141) that Pastorff, of Buchholz, an attentive observer of the solar spots, saw twice in 1836 and once in 1837 two round black spots of unequal size, moving across the sun, changing their place rapidly, and pursuing each time routes somewhat different. He found that the two bodies observed Oct. 18, 1836, traversed an arc of 12′ from $2^h\ 20^m$ to $3^h\ 12^m$; that the two observed Nov. 1, from $2^h\ 48^m$ to $3^h\ 42^m$ traversed in this time an arc of 6′, and that the two observed Feb. 16, 1837, traversed an arc of 14′, between $3^h\ 40^m$ and $4^h\ 10^m$. In 1834 Pastorff saw two similar bodies pass six times across the disc of the sun. (*Bib. Univ.*, t. 58.) The larger was about 3″ in diameter and the smaller 1″ or 1″·25. Both appeared perfectly round: sometimes the smaller preceded the larger, sometimes the contrary. The greatest observed distance between them was 1′ 16″. The bodies were often very near each other and their transit then occupied only a few hours. They had the appearance of a dull black spot, like that of Mercury in its transits.

On further search the following statements were found, which may perhaps bear on the case. Flaugergues mentions (*De Zach: Corresp. Astron.*, vol. 13, p. 17, 1825) that Pastorff saw *two* remarkable spots on the sun Oct. 23, 1822, and also spots July 24 and 25, 1823. Olbers (in *Tilloch's Phil. Mag.*, vol. 57, p. 444, 1821) cites Gruithuisen's observations of three solar spots June 26, 1819, viz., one near the middle of the sun, and *two small ones without nebulosity* near the western limb.

M. LeVerrier's new Tables seemed, (by the Report made to the French Academy, Aug. 4, 1845, C. R. 21 : 316.) to show that Mercury suffered no unexplained disturbance. Nevertheless, in the hope of finding this presumed planet I undertook in the year 1847, in conjunction with Mr. Francis Bradley, to observe the sun's disk twice a day when practicable, and also to explore the neighborhood of the sun with a telescope armed in front with a long pasteboard tube blackened inside. These efforts, made with an instrument badly mounted, in an inconvenient place, proved fruitless, and were finally given up on account of the pressure of other work. Such observations ought to be resumed by those who can command suitable means. The fact that for twenty years past no such bodies as those seen by Pastorff have been detected by the numerous observers of solar spots may perhaps be due to the large inclination of the planet's orbit. E. C. Herrick.

2. *Shooting Stars of August* 9–10, 1859.—The following observations by Prof. A. C. Twining at Boston, Mass., and by Mr. Francis Bradley and others at Chicago, Ill., show that the usual meteoric display of August 9–10 occurred this year, but on a scale somewhat reduced. E. C. H.

(1.) *Observations at Boston, Mass., by Prof. Twining.*—"From $2^h\ 15^m$ A. M. to $3^h\ 30^m$ (10th) I observed 45 conformable and 11 unconformable meteors in a space around the radiant whose radius would be about the arc from the Pole to α *Tauri*. The sky clear; paths of meteors not long nor brilliant; two left visible traces for about six seconds. The average place of the radiant during the time of observation was near 38° 30′ A. R. and 57° 15′ N. decl."

(2.) *Observations at Chicago, Ill., by Mr. Francis Bradley and others.*—July 29, 1859, $10\frac{1}{2}$ to $11\frac{1}{2}$ P. M.—watching alone, looking chiefly to the northeast, Mr. B. observed in the hour *sixteen* shooting stars, of which

five or six only were conformable to the August point of radiation. Aug. 5, 11 to 12 P. M.—*nineteen* shooting stars were observed during the hour, seven or eight of which were conformable.

Aug. 9. Observers—Messrs. F. Bradley, Wm. Dickinson, E. P. Marsh, and after 1 of the 10th, Mr. L. Baird. The sky was nearly clear, and the moon interfered until about one o'clock.

Shooting stars observed:

11 to 12 P. M.,	in N.	12	
" "	" W.	7	
" "	" E.	6	——25
12 to 1 A. M., (10th,)	" N.	12	
" "	" W.	13	
" "	" E.	14	——39
1 to 3 A. M.	" N.	54	
" "	" E.	33	
" "	" S.	61	
" "	" W.	78	——226
3 to 3½ P. M.,	" N.	24	
" "	" E.	10	
" "	" S.	22	
" "	" W.	22	——78

The meteors were plainly increasing in frequency during the latter part of the time. Few of them were large, and only a small number of all were unconformable to the point of apparent radiation usual at this date.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquakes in California during* 1858*;* by J. B. Trask, M.D.—During the past year we have had occasion to note the occurrence of eight shocks of earthquake in this State. This number is one half less than that in 1857, and one third less the number in 1856. The shocks with one exception have been unmarked by anything like violence, being little else than mere vibrations or tremors unnoticeable by the great majority of the people. They are as follows:

Feb. 10th.—A smart shock at Kanaka Flat, Sierra Co. No time noted.

Feb. 15th.—A light shock in San Francisco at $4^h\ 20^m$. Was observed in the county of San Mateo ten miles south of the city.

Aug. 19th.—A light shock in San Francisco at $22^h\ 10^m$. The motion was east and west and undulatory.

Sept. 2nd.—A smart shock at Santa Barbara, no time given.

Sept. 3rd.—A smart shock in San Jose at $0^h\ 40^m$. This shock was felt at Santa Cruz 25 miles west, and was evidently more marked in strength at that locality. No damage.

Sept. 12th.—A smart shock at San Francisco at $19^h\ 40^m$. The motion was from north to south. There were two vibrations with undulatory movements lasting about fifteen seconds.

Sept. 26th.—A light shock at San Francisco at $1^h\ 26^m$.

Nov. 26th.—A heavy shock at San Francisco at $0^h\ 34^m$. This shock was by far the heaviest during the year, it awoke most people from slumber and created no little alarm, persons left their beds and sought cooler

situations with less attire than is usually worn. The iron pillars in the second story of the custom house have separated from the ceiling above about half an inch, and are supposed to have settled from the effects of the shock: I much doubt the alleged cause of this displacement, as the pillars below present no indications of similar disturbance. This shock was felt at Oakland ten miles east of the city, but was not felt at Stockton, Sacramento, or Marysville. It was evidently confined to an area of ten or twelve miles.

Up to this date, (Aug. 10th, 1859,) there have been but three shocks during the present year.

2. *Eruption of Mount Hood.* (Extract from a private letter dated San Francisco, Sept. 4th, 1859).—"On the 15th, 16th and 17th of August, 1859, the atmosphere at this place (Portland, Oregon,) began to grow quite sultry, on the 17th the air very soon after ten o'clock became exceedingly hot, a very unusual circumstance here. The sky up to noon was nearly cloudless, but after meridian the heavens assumed an unusual aspect; on directing our attention toward Mt. Hood we all observed a most singular collection of clouds hovering over the summit, having a light silvery aspect, mingled with others of darker hue, heavy and apparently lowering. Up to the close of the following day nothing else unusual had occurred, the clouds still hanging over the mountain. On the evening of the 18th flashes of light were frequent from about the summit, and a full volume of illuminated vapor at times would ascend. On the 19th and 20th heavy volumes of cloudy vapor continually poured out from the crater, and on the evenings of these days the shafts of flame were almost constant, the light was continuous through the night. On the 20th the smoke cleared up for a short time affording a view of the summit, it was observed to have changed its aspect to the naked eye, but with glasses the upper northwest side of the summit had disappeared entirely, it had the appearance of an immense gap, the presumption is that it has fallen in. There are parties on their way to the mountain to explore it, and on their return I will write you again."

3. *Improved mode of preparing Diatomaceæ;* by Christopher Johnston, M.D. (In a letter to the editors dated Baltimore, Md., Sept. 14th, 1859.)—Allow me to offer an improvement in the preparation of guano, diatomaceous earth, &c., for mounting either dry or in balsam. It consists in the substitution of chlorate of soda for the chlorate of potash employed according to Bailey's method; and the whole process may be thus summed up. 1. (Say for guano) wash in water. 2. Boil in nitric acid. 3. Pour off the acid from the sediment, add fresh acid, boil for fifteen minutes, pour in a little muriatic acid and boil for five minutes. 4. After complete washing out of the acids, carbonize the residue with strong sulphuric acid; effect the combustion of the carbonized portion with *chlorate of soda;* wash perfectly with water, and the diatoms need no further treatment.

Two things are gained by this method; 1st. Sulphate of soda is very soluble and may easily be removed by washing—this is not the case with sulphate of potash. 2d. It renders unnecessary a new boiling in acid of the residual sand, diatoms, &c., as recently proposed by a distinguished practical microscopist of this country for the perfect removal or destruction of sulphate of potash remaining *in* or about the diatoms. Protracted

boiling in strong acids injure the valves of diatoms, and especially those which have delicate markings; Bailey's method as modified by your subscriber subjects them to the least possible risk of being broken or defaced.

4. *Proposition for a Humboldt Fund for Scientific Investigations and Travels.*—[We have received from the venerable and distinguished Carl Ritter,* the illustrious Geographer of Berlin, the following "Proposition," and take pleasure in laying it before the American public in the hope that the appeal which it impliedly contains for American contributions may not be in vain. We shall be very happy to receive and transmit to Berlin any contributions to the HUMBOLDT FUND which the friends of science may entrust to us.—EDS.]

"In the course of centuries there springs up here and there a man who, uniting powers of investigation and generalization, like Aristotle or Leibnitz, represents in himself the multifarious science of his time. Among these few powerful minds belongs ALEXANDER VON HUMBOLDT; bold and cautious, profound and comprehensive, alike fertile and brilliant, a pride and a joy to his contemporaries of both hemispheres. What he brought to life in science will never die, but will continue bearing fruit by its own inherent power. But his place in the world is left vacant, and that prompt and helpful love, that unwearied and fostering zeal which the struggling scientific talent of every land found in him are departed. No one can render aid productive of such results as that rendered to science by Alexander von Humboldt. Nevertheless it is a natural wish to perpetuate beyond his life through an Institution, this noble department of his activity.

"It is therefore proposed to found an institution under the name of the *Humboldt-Stiftung*, having for its object to afford assistance to rising talent, wherever it may be found, in those directions to which Humboldt devoted his scientific energies, viz., scientific labors, and extensive journeys of exploration.

"It is proposed to confide the distribution of any means obtained for this purpose to the scientific body of which he has been a faithful and efficient member for sixty years, and which only a few weeks before his death listened to his animating voice, viz., the Royal Acad. of Sciences at Berlin.

"This body upon the proposal being made, has declared itself ready to draft and in conjunction with the Committee to establish the statutes of the Association, adapted to the amount of capital subscribed, and to apply its resources worthily in assisting promising or already developed talent. In pursuing such an aim we recognize the hindrances which arise from the circumstances of this particular period. But we do not shrink in these excited days of war from quietly carrying forward the everlasting mission of peace entrusted to science, which binds all nations in one.

"It is due to the memory of Alexander von Humboldt, and it seems to us no impracticable thought, to unite in one efficient body the Princes who honored him, the members of that Nobility to which he by birth belonged, the scientific litterateurs who admired him, learned men who were enchained by his cosmopolitan spirit, the circle of trade who profited by his discoveries, the prominent persons in cultivated European circles where he worked, as well as in other lands of both worlds—to unite them all so as to form a living monument to his name, which shall work on for science from age to age.

* Whose demise we have to lament since writing these lines.—See p. 451.

"In this feeling we take the liberty of inviting a collection for the Humboldt-Stiftung, and beg that subscriptions may be sent to the banking house of Mendelsshon & Co., in Berlin. The collected capital will be invested with prudence and the interest applied to the specified objects. In six months a report will be rendered to the public.

"We recommend then in full confidence to the active friendship of all who recognize in truth and gratitude the greatness of the departed, an institution which will work down to remote ages in Humboldt's spirit, and do honor to his name."

[This memorial is signed by F. v. Bunsen, Ehrenberg, Dove, Encke, Lepsius, Magnus, Ritter, and sixteen others.]

5. *The 29th Meeting of the British Association for the Advancement of Science* was held at Aberdeen, Scotland, commencing on the 14th of September.—It was graced by the presence and the hospitality of Royalty. The Prince Consort made a very sensible opening speech, and the meeting appears to have been in all respects a good one.

6. Prof. J. D. Dana sailed for Europe in October, for an absence of about a year. Rest from his too severe and long continued scientific labors which had begun to tell upon his health, was the leading motive of his journey. He spends the winter in southern Italy.

7. Prof. Agassiz returned in September from his late visit to Switzerland refreshed in health and spirits, and laden with treasures for the new museum at Cambridge, the building for which we learn is rapidly approaching completion.

8. *Government Scientific Expedition in New Mexico.*—In our notice of Dr. Newberry's *New Mexican Explorations* on page 298 of this volume, we inadvertently neglected to say that Dr. Newberry is connected with a government expedition under the War Department, commanded by Capt. McComb of the U. S. Army, under whose direction the investigations are being made.

9. *Journal of the American Oriental Society.* Vol. vi, No. 1.—This Society, in its zealous cultivation of oriental literature, has just now been placing the scientific world under special obligations. Two important papers, revealing to the English reader some of the treasures of Oriental science, occupy nearly the entire number of the Journal now before us, the annual half volume for the current year.

The first is an article of 128 pages by the Chevalier N. Khanikoff, Russian Consul-General at Tabríz, Persia. It consists of an analysis and extracts of an Arabic work on the water-balance, written by 'al-Khâzinî in the twelfth century, and entitled *Book of the Balance of Wisdom.* This paper, originally in French, the Committee of Publication have here presented in English, with a translation *de novo* of the extended extracts from the original work, which are here printed in Arabic, in connection with the portions of the article to which they belong. The committee have also appended a large body of critical and explanatory notes.

The Balance of Wisdom or Water-Balance, is a balance for determining specific gravities; and the Arabic work here analyzed and translated is a systematic treatise on the subject, containing descriptions in detail, with figures of several ingenious forms of such balances; also expositions of the philosophical and mechanical principles involved in their construction and use, together with experimental results. It is a curious and very instructive monument of the state of experimental philosophy among the Arabs, at a time when they became almost the sole custodians of the

science of the world; the treasures which they had obtained by conquest from Greece and India being faithfully kept by them during the long eclipse of European learning until the western nations, emerging from the darkness, were ready to receive them at their hands, and under the influence of a higher civilization develop the germs thus providentially preserved into the rich fruits of modern science.

We quote a few specimens of the results for specific gravities given in the "Book of the Balance of Wisdom," in connection with modern determinations.

Substances.	acc. to 'al-Khâzinî.	Modern authorities.
Gold,	19·05	19·26–19·3
Mercury,	13·56	13·56–13·59
Lead,	11·32	11·35–11·44
Silver,	10·30	10·43–10·47
Copper,	8·66	8·67– 8·85
Brass,	8·57	8·40– 8·60
Iron,	7·74	7·6 – 7·79
Tin,	7·32	7·29
Emerald,	2·75	2·68– 2·77
Pearl,	2·60	2·61– 2·75
Salt,	2·19	2·07– 2·17
Wax,	0·95	0·96
Boiling Water,	0·958	0·960
Ice,	0·965	0·916–0·927
Sea Water,	1·041	1·029–1·04
Olive oil,	0·920	0·918–0·919
Human blood,	1·033	1·053

The other article referred to, filling 128 pages, is the first part of a translation from the Sanskrit of one of the oldest and most important text-books of Hindu astronomy, the Sûrya-Siddhânta, with notes and an appendix, by Rev. Ebenezer Burgess, formerly missionary of the A. B. C. F. M. in India, assisted by the Committee of Publication.

We only call attention to this very interesting paper at the present time, as it will deserve a more extended notice when completed. The original work is composed, like most of the Sanskrit literature, in metrical stanzas of two lines each, and its concise and peculiar forms of statement would to a great extent, be unintelligible even when translated, without the full and scholarly commentary which has been supplied by the several editors. This commentary, which is largely indebted for its value to the sound oriental scholarship of Prof. Whitney, and to the mathematical supervision of Prof. Newton, of Yale College, is adapted to the wants of two distinct classes of readers,—those who are orientalists without being astronomers, and those who are astronomers without being orientalists; thus rendering this important exposition of Oriental Astronomy attractive to all those who would learn more distinctly how much the world is indebted to the Hindu mind for so many of the elements of scientific, as well as of general, knowledge.

10. OBITUARY.—PROF. CARL RITTER the distinguished Geographer, died at Berlin, Sept. 28th, in his 81st year. He was born August 8th, 1779.

Death of Dr. Grailich.—We are pained to record the early death of Dr. Joseph Grailich the distinguished crystallographer and physicist. At the time of his decease Dr. Grailich was Professor of mathematical physics in the Imperial University at Vienna and one of the Adjunct Curators of the Imperial Mineral Cabinet. He died at Vienna on the 13th of September in the 31st year of his age.

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